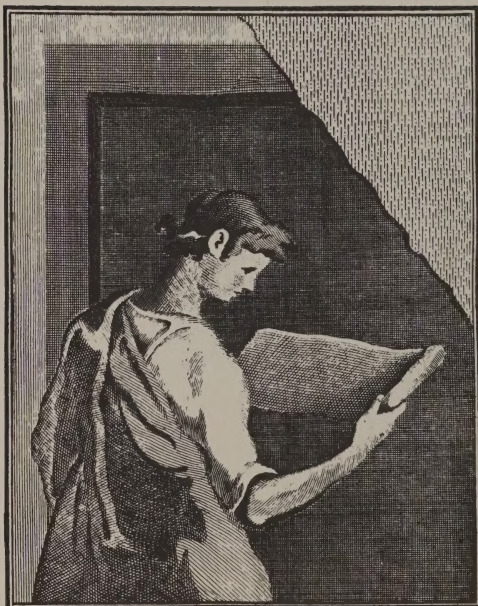
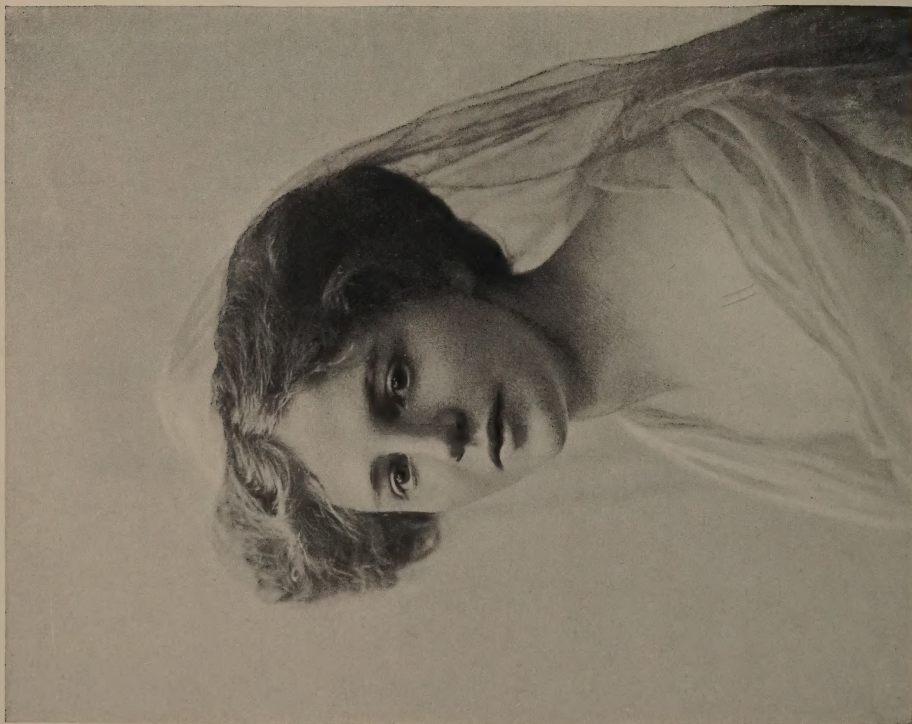




THE GETTY CENTER LIBRARY



TWO PORTRAITS OF ONE SUBJECT, SHOWING THE
EFFECTS OF DIFFERENT DRAPING AND LIGHTING



BY PERCY R. SALMON, F.R.P.S.

HOME PORTRAITURE

CASSELL'S CYCLOPAEDIA OF PHOTOGRAPHY

EDITED BY
BERNARD E. JONES

ILLUSTRATED BY TWENTY-FOUR FULL-PAGE
PLATES IN COLOUR AND HALF-TONE, AND BY
HUNDREDS OF LINE DRAWINGS IN THE TEXT

VOLUME II

CASSELL AND COMPANY, LTD.
43-45 East 19th Street New York

1912

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HADDON'S FORMULÆ

Many useful formulæ due to A. Haddon are in use, three of the best known being given below :—

Reducer for Negatives and P.O.P.—This consists of potassium ferricyanide and ammonium sulphocyanide, and is compounded as follows :—

For negatives—

Potassium ferricyanide	10 grs.	11 g.
Ammonium sulphocyanide	20 „	22 „
Water	2 oz.	1,000 ccs.

This reducer has the merit of keeping well. The plate is immersed in the solution in the usual manner, rocked until reduction is sufficient, and then washed for ten minutes. A dry negative should be first soaked in water.

For P.O.P.—

Potassium ferricyanide	4 grs.	4.4 g.
Ammonium sulphocyanide	20 „	22 „
Water	2 oz.	1,000 ccs.

Platinum Toning Bath for P.O.P.—This is a toning bath on the lines suggested by Henderson. The formula is :—

Platinum perchloride	15 grs.	1 g.
Sodium formate	500 „	32.5 „
Water	175 „	11.5 „
Formic acid	150 mins.	9 ccs.

Before treatment, the prints must be washed in a salt and water bath (salt 1 oz., water 20 oz.) prior to toning. Fix and wash as usual.

Mercury Intensification.—For the purpose of eliminating from a mercury-bleached negative the last traces of a compound formed by the mercuric salt combining with the gelatine, Haddon has strongly advocated the use of hydrochloric acid. The bleached negative must be washed for ten minutes, and then immersed for three or four minutes in a bath consisting of 1 dram of hydrochloric acid and 10 oz. of water. Next it is rinsed in water and transferred to a second acid bath, rinsed again, and placed in a third, then washed in several changes of water, and finally blackened as described under the heading "Intensification."

HALATION (Fr., *Halation*, *Aurêolage*; Ger., *Lichtfleck*)

A halo-like, blurred effect, frequently seen surrounding a brightly lit portion of a photographic image, caused either by reflection from the back of the glass plate or by lateral spreading of light in the film. The defect has been observed from the earliest days of photography, but it became more common on the introduction of glass plates. It is believed that the first mention of the word in print occurred in the year 1859. Halation is usually seen in its most aggravated form in a photograph of a dark

interior which includes a bright window. The latter will not be clearly outlined, and all round it there will be fog. Halation also appears sometimes when the roof of a house or a tree cuts against the sky; around a white collar or dress in a portrait; and, in fact, in all subjects where a very bright line comes in sharp contrast with a deep shadow. The chief cause of halation is the reflection from the back of the plate of the bright beam of light that reached it. In the illustration, the plate is shown in a vertical position, A being the film side and B the plain glass side or back of the plate. EF represents a ray of light coming from the lens and striking the film at F, part of it being reflected along the line FG and being dispersed in the camera. The light being strong and the sensitive film translucent, some of the light passes through the film and strikes the back of the plate at J. If all the light continued its way

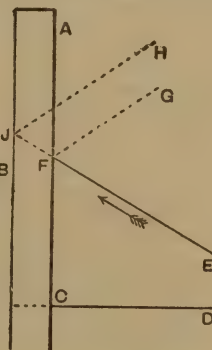


Diagram Showing Chief Cause of Halation

and went out at the back, it would do little or no damage, but instead at J another reflection takes place, as at JH, and the light passes again through the film and causes fog on the other parts. Assuming that a bright window in a dark interior is being pictured on the plate, and that the part below F represents the window, and the part above F the dark wall of the room, some of the light rays EF from the window would pass through the plate to J and be reflected to H, thus causing the sharp outline of the window to be blurred. When the bright object comes at the side of the plate, the halation is usually worse than when it comes in the centre, because rays of light which strike the plate almost at right angles to its surface at CD are reflected back through the film at practically the same places through which the light first passed. As the degree of obliquity increases, the amount of reflection increases also, until at a certain angle, varying with the refractive index of the glass, the whole of the light is reflected. The

thicker the glass plate the greater will be the extent of the halation, because of the wider angle formed by the reflected rays; this explains in part why the thin celluloid films do not show appreciable halation. A contributory cause of halation is under-exposure and forced development, conditions that are more often responsible for the defect than are the direct causes. As a rule, the quicker a plate is developed the less will halation show.

It will be seen that the principal causes of halation are (a) the translucency of the emulsion, and (b) the reflective power of the back of the glass. Some remedies are at once obvious. (1) To replace the glass with paper or other non-reflecting support. (2) To stain the film or in other ways to make it so opaque as not to allow the rays to penetrate the glass. (3) To prevent the back reflection by coating the plain glass side with a non-reflecting or absorbing medium. Others have also been suggested. The third remedy, that of coating the back of the plate before exposure with some non-actinic and non-reflective substance, is in general use, and has been found the most convenient and effective in practice. Formulae for suitable mixtures are given under the heading "Backings, Plate."

In process work, it is found advisable to back dry plates with caramel or other medium to prevent halation, which would rob the half-tone dots of their sharpness. A sharp dot is an essential in half-tone work.

HALF-PLATE

A commercial size of dry plate and printing paper, measuring $6\frac{1}{2}$ in. by $4\frac{3}{4}$ in., and largely used for "cabinet" portraits and occasionally as a stereoscopic size.

HALF-TONE PROCESS (Fr., *Procédé en demi-teintes* or *Simili*; Ger., *Halbtonverfahung* or *Autotypie*)

A process in which the half-tones of a photograph are reproduced by breaking up the image into dots of varying size, transferring this dot image to a metal plate, and etching the dots into relief for typographic printing. The shades of colour or tone between black and white in the photographic image are termed half-tones. To reproduce these half-tones in a block for typographic printing, in which a uniform layer of ink must be employed, it is necessary to break up the image into fine dots of varying size—largest, and therefore printing darkest, in the shadows, and smallest, therefore printing lightest, in the high lights; the intermediate sizes printing the half tones.

The credit of the idea of breaking up the image into dots by means of a network screen is due to Fox Talbot, who proposed it in a patent dated 1852. He used crape, or gauze, but also suggested the use of a glass plate ruled with fine opaque lines, which latter is the means employed to-day for executing the process. Various experimenters carried on the process with gauze, or with lines on glass obtained by photographing lines ruled or printed on paper, and with lines ruled through a blackened ground on glass, but it was not until 1893, when Max Levy, of Philadelphia, patented and introduced commercially his process of engraving and etch-

ing the lines into the glass and filling in the furrows with black pigment that the process became a commercial success. The Levy screen consists of parallel lines ruled diagonally on two glasses, which are sealed together face to face with Canada balsam, thus forming a network of crossed lines. Varying degrees of ruling are used, from fifty-five lines per inch (for coarse newspaper work) up to 400 lines per inch, according to the degree of fineness required in the block. Ordinary magazine illustrations are made through a screen of about 133 to 150 per inch; the half-tone plates accompanying this work were made through screens of 175 and 200.

In carrying out the process the screen is placed in a holder in front of the sensitive plate, and, by means of mechanism in the back of the camera, is moved nearer to or further from the plate according to the extension of the camera and the degree of the ruling—long extension of the camera requiring greatest distance of the screen, and fine rulings the smallest distance. Some cameras are fitted with screen adjustment gear. Square, cross, star, and other shaped diaphragms are put in the lens, alternately with the usual round diaphragm, the object being to promote the better formation of the dots.

The negative is made either by the wet or dry plate process, or with collodion emulsion, the first-named process being generally preferred, and it needs to be developed, intensified, and cleared to sharpen up the dots. A copper or zinc plate is coated with a solution of fish-glue and ammonium bichromate (see "Enameline" and "Fish-glue"), and exposed to light under the negative. The image is developed by dyeing the plate with aniline violet and washing with water until the dots stand out clear on the bare metal. The plate after being dried is held in pincers over a gas-stove until the image is "burnt-in" or converted into an enamel which is extremely acid-resisting.

The etching is done with dilute nitric acid for zinc, or with ferric perchloride for copper, and it is carried to such a depth as will prevent the printing ink from filling up the spaces between the dots.

To increase contrast and to bring out detail, the plates are usually "fine etched." Parts that are sufficiently etched in the first or "deep" etching are stopped out with acid-resisting varnish, and the remaining parts again etched; this may be repeated several times.

The plate is finally trimmed to size, the edges bevelled with a special plane or machine, and fastened to a wooden mount or block by nails driven through the bevelled edge; or a metal block may be used. The mount brings the plate to type height, so that the block can be printed along with type. W. G.

HALF-TONE SCREEN

A glass plate, or pair of plates sealed together, ruled with parallel lines, usually crossed, to form a network or grating, which is placed in front of the sensitive plate to break up the photographic image into a series of dots, in order that the half-tones may be reproduced. The commercial half-tone screen was introduced by Max Levy, as stated under the heading "Half-tone Process."

HALLOTYPE (See "Hellenotype.")

HALOGENS (Fr., *Halogènes* ; Ger., *Halogene*)

The four elements, bromine, chlorine, fluorine, and iodine, are thus called because they form very marked salts with metals.

HALOID (Fr., *Haloïde* ; Ger., *Halogenverbindung*)

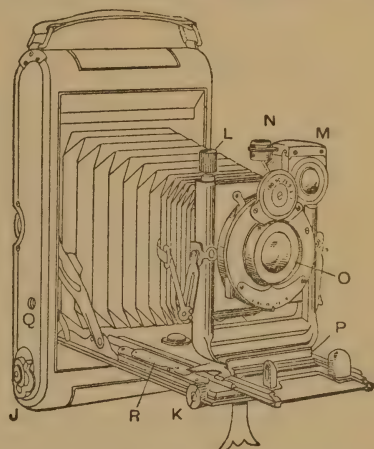
Synonym, halide. Applied to compounds containing one of the four halogens; for instance, a silver or alkaline haloid or halide is spoken of.

HAND CAMERA (Fr., *Chambre à main*, *Chambre détective* ; Ger., *Handkamera*, *Detectiv-kamera*, *Geheimkamera*.)

A camera sufficiently light and portable to be used in the hand, instead of on a stand. A collapsible pocket camera having a cloth body was suggested by Edwards as early as 1855. In 1860 and 1861 hand cameras of fixed focus with bodies of wood or metal were constructed by Bertsch and by Ottewill, and in the latter year magazine changing-boxes were in use. Enjalbert in 1887 used a leather changing-bag attached to the camera, with a lever for lifting the plates as exposed. The first approximation, however, to the convenience of the modern hand camera appears to be due to Thomas Bolas, who in 1881 described several forms of what he termed "detective cameras," with twin lenses, a focusing arrangement, and a pneumatic release for the shutter. A reflecting prism was placed in front of the lens so that it might be pointed at a right angle to the direction of the object to be photographed, and thus worked without exciting suspicion.

The simplest pattern of hand camera is the box form, which is usually of fixed focus, the lens being incapable of movement and so adjusted that all objects beyond about seven yards distant will be rendered sufficiently sharp. A typical box form camera for films A has two finders *K* and *L*, for sighting the object,

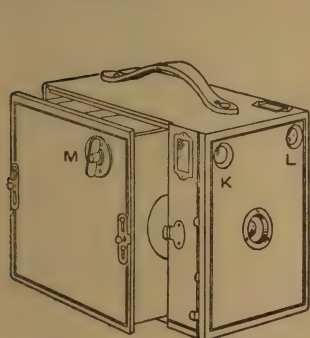
for plates being shown at B. In this model, focusing is effected by turning a milled screw *O*; a hinged door at the front allows access to the lens and shutter, and permits the storage of the pneumatic ball and tubing in the recess.



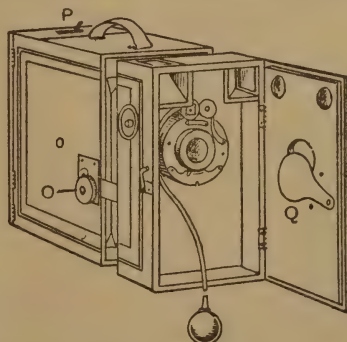
D. Folding Hand Camera for Films

A trigger release is worked by a push at the side; *P* is the lever actuating the plate-changing mechanism, and *Q*, pivoted to the door, acts as a dust excluder.

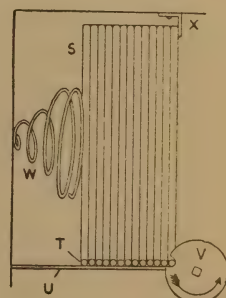
The details of the plate-changing mechanism differ considerably: C illustrates one effective arrangement, introduced by McKellen. The metal sheaths *s* containing the plates have projecting pins *r* at their bottom corners, which rest on grooved guide plates *u* at the sides of the camera. At the end of each groove is a circular hollow, in which turns a revolving disc *v*, the two discs being mounted on the same shaft. Each disc has a notch in it capable of receiving the pins of the sheaths. The sheaths are pressed forward by the spring *w*, when the



A. Box-form Fixed-focus Camera



B. Box-form Focusing Camera



C. McKellen Plate-Changing Mechanism

one for vertical and one for horizontal pictures. The inner case is shown partly withdrawn, *M* being the key by which the film is wound. Box-form hand cameras are also made to hold a magazine of plates in sheaths or for use with ordinary dark-slides. Besides the fixed-focus type, they are obtainable with a focusing arrangement working by scale, one of this kind

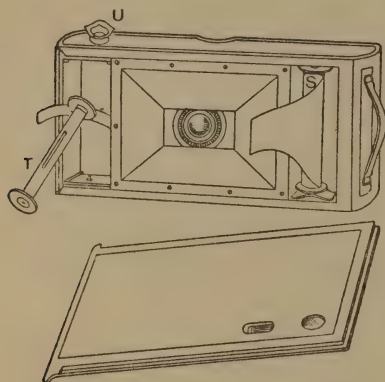
front one bears at the top against a stop-rail *x* and is supported at the bottom by its pins engaging in the notched wheels. To change a plate, the wheels are turned simultaneously by means of a handle outside the camera, thus carrying down the front sheath, the pins of which remain caught in the notches until the top clears the stop-rail *x*. The sheath now falls

into the bottom of the camera, and the handle is turned in the reverse direction until the wheels engage with the pins of the second sheath, which is then in position for exposure.

A representative example of a folding hand

has been made winding is continued until all the black paper has been wound off the original spool, when the camera back may be opened and the exposed spool withdrawn.

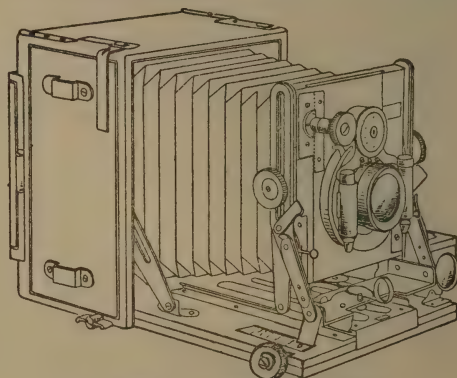
A folding camera for plates is illustrated at



E. Winding Mechanism for Films

camera for films is shown at D. The principal movements and fittings are: J, key for winding film; K, focusing screw; L, rising-front pinion; M, finder; N, spirit level; O, lens with diaphragm shutter; P, cross-front movement; Q, bush for tripod screw, for attaching the camera to a stand if required; R, focusing scale.

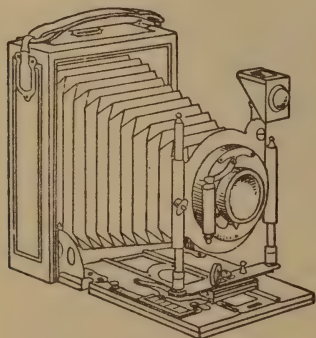
The winding mechanism for films usually varies little from the system shown at E. Having removed the sliding back, a charged spool of film S is placed in a recess at one side of the camera and fits on two small pegs. An empty spool T fits a recess at the opposite side, and is turned by the winding screw U which engages in one of its ends. Having inserted both spools, the end of the black paper on the full one is drawn out until it can be pushed through the slot seen on the empty spool, and the key is given a single turn. The back is then replaced



G. "Hand or Stand" Camera

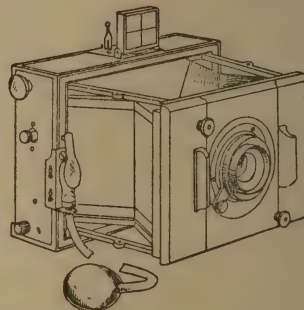
F. A more substantial and elaborate example of what is known as the "hand or stand" type is shown at G; this can be employed for nearly all descriptions of work, being either held in the hand or supported by a stand.

Yet another class of hand camera is that in which a focal plane shutter is used, for high-speed exposures, as required in press work and sports photography. A typical folding focal plane camera is shown at H. In use, it is held up to the level of the eye, the subject being viewed through a direct-vision finder, consisting either of a small concave lens with cross-lines and sight, as illustrated, or a rectangular wire frame. There is a growing tendency among press workers to prefer the focal plane to the reflex camera on account of its lightness and lesser bulk, besides the fact that it is held at a more generally useful height. The reflex and twin-lens cameras have, however, the great advantage of giving a full-size image in the finder, which may be watched and focused



F. Folding Camera for Plates

and the key turned until the first number on the black paper appears at the small ruby window in the rear of the camera; it is then known that the first film is in position for exposure. The remaining numbers are wound forward as required, and when the last exposure



H. Folding Focal Plane Camera

right up to the moment of exposure. These cameras form a class by themselves, and will receive separate treatment. (See also "Detective Camera," "Magazine Camera," "Pocket Camera," "Reflex Camera," "Twin-lens Camera," etc.)

HAND CAMERA, WORK WITH

It considerably enlarges the scope of the photographer's work to become expert in the use of the hand camera. But the hand-camera worker matures only with time, patience, practice and experience. Moreover, there are special considerations to be taken into account before it is possible to do consistently good work with a camera that not only has to be used in the hand, but has to be brought into operation with trying rapidity. One of the most important points is familiarity with the camera itself. It should be known and understood down to its smallest detail. Every operation involved in making an exposure and changing the plate or film must be so familiar that it can be performed rapidly and almost mechanically. There must be practically no risk of bungling or blundering.

The use of a reflex camera removes any doubt as to what is sharply focused and what is included on the plate. With other patterns it is necessary to learn to estimate distances with approximate accuracy. It is also useful to know the depth of focus at different distances and with different lens apertures; and to know the distance (with the particular lens in use) at which a full-length figure will come the right size on the plate. When there is any uncertainty as to the precise distance of the object to be focused, it is well to err on the near side, as the depth of focus is always greater on the farther side than on the nearer side of the point focused upon.

In the absence of a full-sized finder it is advisable to have the small finders as accurate as possible. In practice it is better that they should show rather less than is actually included on the plate. When the plate used is a very small one it is more than ever necessary that the subject should be accurately placed upon it, as there is no room to be wasted. Many failures result in the use of small cameras from this cause, particularly when reliance is placed on finders so minute as to be worse than useless. It is generally worth while to fit such small cameras with a removable finder that will show on a reasonably large scale just what will appear on the plate.

It is also of vital importance to be able to hold the camera level and steady during exposure. The duration of exposure that can be given with safety depends largely on the individual, but also to a great extent on the type of camera in use and on the position in which it is held. A large, heavy camera can generally be held steadier than a small, light one; and it is safer to hold the camera pressed against the body than at arm's length or at eye-level. The type of shutter and its smoothness of working must also be considered a factor. When all conditions are favourable, an exposure of a full second should be safely attainable. Another point that should be constantly borne in mind is that proper exposure is necessary. It may be thought that such a consideration does not apply particularly to hand-camera work. But, unfortunately, there is too often an idea that with a hand camera there is some magic property enabling much shorter exposures to be given than if the same camera happened to be set upon a tripod. Naturally, the exposures given

with a hand camera are more or less rapid, but they are only properly effective when the conditions obtaining demand just those exposures. An exposure-meter, or some similar guide, is every whit as essential in work with the hand camera as with the stand camera. A further aid to successful hand-camera work is the cultivation of a quick eye. This in itself is but small gain without the addition of dexterity in manipulation. It is often imperative that the camera shall be used quite unobtrusively, and rapidity and certainty of working thus become a valuable asset.

The results obtained with a hand camera are largely employed for the production of either lantern slides or enlargements. Hence it behoves the hand-camera worker to aim at the most perfect technical excellence to which he can attain. He should keep his apparatus free from dust, pay the most extreme attention to exposure and development, and strive to produce a spotlessly perfect negative from every plate or film exposed. He should absolutely rid his mind of any idea that good work with a hand camera can be obtained in a haphazard and slipshod manner. All the judgment, consideration, and care that are devoted to work with the stand camera must equally be given to hand-camera work; and in addition further attention must be paid to the added difficulties arising from the often rapid use of a camera held in the hand. Only so can a high standard of excellence be achieved. W. L. F. W.

HARD NEGATIVES

Negatives in which the gradations are harsh, irrespective of the total range of contrasts. A thin negative may be hard, as the gradations may be very harshly rendered as a result of shortness of exposure. The term is frequently applied incorrectly to negatives that are too strong in contrast with good gradation. If the gradation is good the negative is not hard or harsh. Methods of treating hard negatives are given under the heading "Harmonising Contrasts."

HARD PRINTS

These naturally result from using hard or harsh negatives, or those that are too strong in contrast for the printing process employed, without being harsh. There is no satisfactory method of treating the prints when once made. The best course to follow is to modify the negative by the methods given under the heading "Harmonising Contrasts," or to modify the print during its exposure by the methods explained under the heading "Control in Printing." A negative may yield a harsh result in one process and possibly a more satisfactory print in another one.

HARD WATER (Fr., *Eau calcaire*; Ger., *Hartes Wasser*)

Water containing carbonates and sulphates of lime and other earthy salts. Some of these may be removed by boiling, allowing to cool, and then filtering; and all water for photographic purposes should be so treated, although it is far better to use nothing but distilled water for all solutions.

HARDENERS

Solutions used for hardening the films of gelatine negatives and prints with the object of preventing frilling and blistering. Their use is not so necessary now as it was in the early days of gelatine plates and papers, as means of hardening the gelatine during its manufacture are now employed. As, however, the melting point of wet gelatine is about 90° F. (about 32° C.), hardening solutions are still necessary in the tropics, and in colder parts of the world when the films are to be heated to beyond the normal temperature. Chemicals which possess the property of hardening gelatine may be mixed with the "hypo" bath or used separately. Baths which fix and harden at the same time will be found under "Fixing-hardening Baths," but frequently it would be fatal to leave the hardening until fixing, as the harm may be done in developing or toning. Formaline, ordinary alum, and chrome alum are the commonest hardeners, others being potassium nitrate, aluminium chloride, and aluminium sulphate. Formaline is by far the most satisfactory, 1 oz. of formaline being added to 10 oz. of water; this requires about five minutes for complete action, but may be used weaker if desired—say, one part in twenty—in which case fifteen minutes' immersion will be necessary. The stronger bath is the less safe of the two, and may cause the film to become horn-like, crack, and leave the support. The formaline solution should be distinctly alkaline, inasmuch as acid and neutral solutions have but very little hardening effect upon gelatine; also care should be taken that the hardening action goes right through the film and not merely half way.

Chrome alum is next best; a suitable strength is $\frac{1}{2}$ oz. to 15 oz. of water. Its tanning action is greater than that of ordinary white alum, and although it has a deep rich colour, it does not stain the film. Namias recommends the following chrome alum mixture, and states that it has great hardening action: Dissolve 1 oz. of chrome alum in $\frac{1}{2}$ pint of cold water, and add liquor ammoniæ slowly until a pale green precipitate is plainly visible. Then add $\frac{1}{2}$ pint of a 10 per cent. solution of ordinary alum, and boil the whole for about three minutes; when cool it is ready for use. Immerse negative or print from ten to twenty minutes. Ordinary alum (sodium, potassium, or ammonium alum) was at one time very popular as a film hardener, but it is not considered to be as safe as formaline or chrome alum. The proper strength is 1 oz. to the pint of water. The plate or print should be immersed for from ten to twenty minutes. Any of the above hardeners may be used either before or after developing, toning, etc., but it is always necessary to wash well before and after treatment, more particularly when ordinary alum is used after developing and before fixing; otherwise, ugly scum-like markings appear on the negative, and these cannot be removed. Alum markings are due to alkali from the developer remaining in the film, combining with the alum and precipitating aluminium hydroxide. When alum hardeners are used after development the alkali from the developer can be destroyed by rinsing the developed plate in a weak solution of citric acid.

In process work, hardening solutions are useful. In the Paynetype process the plate is immersed in a 5 per cent. solution of potassium bichromate for three minutes, which hardens the gelatine image to such an extent that it can be developed like a carbon print. In the enamel process on zinc it is recommended that, after developing thoroughly, the plate should be placed for three minutes in a bath of—

Ammonium bichromate	. 2 oz.	44 g.
Chromic acid	. . . $\frac{1}{2}$ "	11 "
Methylated spirit	. . . 5 "	100 ccs.
Water	. . . 50 "	1,000 "

Wash, dry, and burn in. The image then resists the acid better. (See also "Fixing-hardening Baths.")

HARDWICH, T. FREDERICK

Born at Wells, in 1829; died at Shotton Vicarage, Durham, 1890. Author of "Photographic Chemistry" (published March 12, 1855). Professor of Photography at King's College, London. He made important investigations (from 1854 to 1861) in the preparation of collodion, and made many improvements in the optical lantern. In 1861 he took holy orders.

HARMONISING CONTRASTS

Harsh contrasts may be softened by chemically treating the negative or by means of control in printing. As a general principle, when the contrasts are due to under-exposure, the plate should be treated with the ammonium persulphate reducer; but if reduction is carried too far, the weak shadow detail will suffer. When the contrasts that require harmonising are due to excessive contrast in the subject, or where some portions only are out of harmony with the greater part of the negative, it is preferable to adopt the methods described under "Control in Printing." By chemically reducing the negative, the contrasts throughout are softened, and the gradation of every detail is flattened. By control in printing, the gradation of the various parts remains unchanged in strength, and each is printed with full detail.

HARRISON, W. H.

Born 1841; died August 10, 1897. In 1865 he published his discovery of a bromide emulsion dry plate and the use of an alkaline developer. He was for many years editor of the *Photographic News*.

HARSH NEGATIVES

For a definition of a harsh negative, see under the heading "Hard Negatives." Harsh negatives may be improved by the methods given under the heading "Harmonising Contrasts" above.

HARTSHORN, SPIRIT OF (See "Ammonia.")

HAT CAMERA (Fr., *Le Photo-chapeau*; Ger., *Hutkamera*)

A detective camera, concealed inside a hat. The lens worked through a small opening in the side of the hat, normally closed by the shutter, while the exposure was given by pulling a cord made to resemble a hat-guard.

HEAD REST (See "Posing Chairs and Head Rests.")

HEAD SCREEN

A reflector used in portraiture for cutting off top light or for lighting the side of the face that is in shadow. Many shapes and styles are obtainable commercially, but essentially it is a frame, covered with light-coloured material, arranged to stand at any suitable angle.

HEATING SOLUTIONS

The important part which the temperature of photographic solutions plays as regards their activity cannot be overlooked, and much more reliable and uniform results will be obtained if they are always heated to a uniform temperature, about 65° F. (about 18° C.). As a rule, it will be found quite sufficient to place the stock bottle or measure full of the solution in any convenient outer vessel, which should then be filled up to the level of the liquid in the bottle with warm water.

HEAVY SPAR (See "Barium Sulphate.")

HECTOGRAM, HECTOLITRE ETC. (See "Weights and Measures.")

HELIAR LENS

A rapid anastigmatic lens introduced by Voigtländer. It consists of two cemented combinations, and a central negative lens. It is made in focal lengths from 2 in. to 24 in., all sizes having an aperture of $f/4.5$.

HELIOCHROME (Fr., *Héliochrome*; Ger., *Farbenphotographie*)

A photograph in colours. (See "Heliography.")

HELIOCHROMY (Fr., *Chromophotographie*, *Héliochromie*; Ger., *Heliographie*, *Farbenphotographie*)

The name given by Niepce de St. Victor to his method of colour photography, discovered in 1853, but now applied to all such processes. St. Victor, following Becquerel, used a film of silver chloride on a silver-coated plate. Various methods were employed to chlorise the plates, one being to dip them in a weak solution of sodium hypochlorite (sp. gr. 1.35) until of a bright, pinkish hue. The plates were then covered with a solution of dextrine saturated with lead chloride, dried, and subsequently submitted to the action of heat. Rather long exposures were required in the camera, the plate being then again heated to render the resulting pictures a little less fugitive. Some vivid colour reproductions were obtained, which unfortunately quickly faded, since no means of fixing could be found. A slight access of stability was secured by covering the plate with an alcoholic solution of gum benzoin.

HELIOGRAPH (Fr., *Héliographe*; Ger., *Heliograph*)

A photograph or engraved plate made by Niepce's bitumen process (see "Heliography"). All photographs were for some time called heliographs.

By means of the spectrum heliograph mono-

chromatic images of the sun are obtained. Referring to the illustration, the image of the sun is formed by the lens C on the slit S_1 , and is projected by the lens L_1 on the prism P; by this it is dispersed and reflected by the mirror M, and thence brought to a focus by the lens L_2 on the plate F. The whole arrangement is mounted on the platform A A A A, which is movable to and fro in the direction of the arrows. S_2 is used to isolate one particular Fraunhofer line in the spectrum, either the hydrogen F line

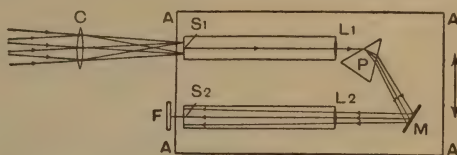


Diagram Showing Principle of Spectrum Heliograph

or H the calcium line. Now the image at S_1 is fixed, but S_1 itself moves; therefore successive portions of the sun's surface are exposed exactly as though a narrow slit focal plane shutter were used. As the prism, mirror, and L_2 are all fixed, and S_2 is arranged to isolate one line, it is obvious that by moving the platform we obtain monochromatic images of the sun on the plate F, which is fixed and does not move with the platform. Some of the most successful photographs of the sun have been taken in this manner, which show most conclusively the distribution of hydrogen or calcium vapour on its surface.

HELIOGRAPHIC PROCESS

A term applied to any method of "sun printing," as used for copying plans, etc.

HELIOGRAPHY (Fr., *Héliographie*; Ger., *Heliographie*)

A process discovered in 1826 by Joseph Nicéphore de Niepce, in which a copper plate coated with silver and covered with a film of bitumen was exposed to light in the camera for some hours. Those parts of the film affected by light became more or less insoluble, according to the extent to which it had acted, whereas the shadow portions or unexposed parts could be dissolved away with oil of lavender. Besides silvered copper, plates of plain copper and other metals were used. Niepce tried to darken the bare portions of the silver, where the shadows should have been, by the application of iodine and other reagents, and also etched some plates with acid, for printing in the press. Such pictures, as well as engravings from the etched plates, were called heliographs, the word "heliography" being then used instead of the modern designation "photography." Niepce's method, in an improved form, is still in use for printing banknotes. The term heliography was for some time employed also in referring to photogravure, but this usage is practically obsolete. (See also "Asphaltum.")

Processes of etching in intaglio on copper by photographic methods are sometimes referred to under the name of heliography, more particularly a process of reproducing maps.

HELIOGRAVURE

Another name for photogravure (*which see*). On the Continent this process is invariably called heliogravure.

HELIOGRAPHY

Solar photography. (*See* "Sun, Photographing the.")

HELIOSTAT (Fr. and Ger., *Heliostat*)

A mirror mounted on a central axis which rotates at the same rate as the earth, so that an image of the sun can be reflected to one constant spot. It is used in photo-micrography when a powerful light is required, and also in spectrography.

HELIOTYPE

A modification of the collotype process, invented by Ernest Edwards, of London. A glass plate is waxed and coated with a substantial layer of gelatine and potassium bichromate, containing a small quantity of chrome alum, which hardens the gelatine and renders it insoluble without destroying its permeability to water. When dry, the gelatine film is removed from the glass, and the surface that has been next the glass is exposed under a reversed negative in the usual way. Then the film is hardened at the back by exposure to light, is attached under water to a metal plate, preferably pewter, coated with indiarubber, and is then squeezed into perfect contact. The bichromate salt is removed by washing, and the plate is ready to be printed from in an ordinary typographic press.

HELLENOTYPE (Fr., *Hellenotype*; Ger., *Hellenotypie*)

A method of colouring photographs, at one time popular in America. Two finished prints were made from the same negative, one rather light and the other strong and vigorous. The lighter one was rendered transparent by the application of varnish and was tinted at the back. It was then adjusted over the stronger print, giving the impression of a photograph in colours.

A slightly different process, known as Halletype, after its inventor, J. B. Hall, of New York, was patented in 1857. Two similar prints were used, one being made transparent by treatment with dammar varnish, and the other painted with washes of colour. The transparent print was laid over the painted one, and the two bound together with a glass and backing, in "passe-partout" style.

HENDERSON, ALEXANDER LAMONT

Born in Scotland, 1838; died at Bad-Nauheim in Germany, 1907. For many years one of the best-known figures in photographic circles. He was a recognised authority on ceramic enamels and emulsion making; he was founder of the London and Provincial Photographic Association (1882), and private photographer to Her Majesty Queen Victoria.

There are many "Henderson" formulæ in use, among the best known being a hydroquinone-metol developer and a combined toning and fixing bath for P.O.P. :—

Hydroquinone-metol Developer.

A. Hydroquinone . . .	100 grs.	11.5 g.
Metol . . .	40 "	4.5 "
Sodium sulphite . . .	960 "	110 "
Water . . .	20 oz.	1,000 ccs.
B. Sodium hydrate . . .	100 grs.	11.5 g.
Potassium carbonate . . .	120 "	14 "
Water . . .	20 oz.	1,000 ccs.

Mix together equal parts of A and B and add potassium bromide as required. If over-exposure is suspected, begin development with an old developer and finish with fresh.

Combined Toning and Fixing Bath for P.O.P.

Sodium hyposulphite . . .	1 oz.	110 g.
Lead nitrate . . .	60 grs.	14 "
Chrome alum . . .	60 "	14 "
Sodium formate . . .	20 "	4.5 "
Formic acid . . .	30 drops	6 ccs.
Hot water . . .	10 oz.	1,000 "

Dissolve the lead and sodium formate in a small quantity of water, add the "hypo" in solution and the formic acid, allow to stand for twenty-four hours in an open vessel, and add 1 or 2 grs. of gold chloride or platinum bichloride.

Henderson's process for the removal of green fog or reducing a negative was to place it over a solution of potassium cyanide for several hours.

HEPWORTH, THOMAS C.

Born, November 3, 1834; died 1905. A well-known writer and lecturer on photographic subjects; for some years proprietor and editor of the *Camera* and also editor of the *Photographic News*.

HERSCHEL, JOHN FREDERICK WILLIAM

Born at Slough, 1792; died at Collingwood, 1871. A famous scientist, who did much for photography in its early days. His name will always be associated with the discovery of the "hypo" fixing bath and of the "blue print" process; he also suggested glass as a support for sensitive emulsion, and experimented with many printing processes, most of which, however, are now obsolete. Knighted, 1831.

HESEKIEL'S PAPER

A platinum paper made by Dr. Hesekei, of Berlin, and introduced into England in November, 1893. It differed from the usual platinum papers chiefly because its surface was granular, and it gave results resembling those of a half-tone process block, owing to the "pyramidal grain."

HIGH LIGHTS

The most brightly illuminated parts of a subject. If these are represented by considerable areas of blank paper the effect is "hard" and unpleasant. High lights should not be scattered about the picture when avoidable, as they draw the eye from one to another, and do not permit of the attention being concentrated. Hence the frequent necessity of "toning down" some of the high lights to avoid "spottiness."

HILL, DAVID OCTAVIUS

Born at Perth, 1802; died 1870. A landscape and portrait painter, and one of the first to apply

photography to portraiture (on the recommendation of Sir David Brewster). Many of his calotypes of eminent men are still in existence.

HILLOTYPES (Fr., *Hillotype*; Ger., *Hillotypie*)

An alleged process of photographing in colours claimed to have been invented by the Rev. Levi L. Hill, of Westkill, New York State, in 1852.

HOAR FROST PICTURES (See "Snow and Hoar Frost Photography.")

HOFMANN'S COLOUR PHOTOGRAPHY

A process in which three constituent negatives were taken and printed on to carbon tissue containing red, yellow, and blue pigments, the developed prints being subsequently superimposed. It was introduced in 1900.

HOLIDAY PHOTOGRAPHY

There are one or two special considerations that press for attention in the case of photographic work undertaken during a holiday. Frequently the work then done is of special interest and importance, and any failure is more serious than in the case of work which can easily be done over again. In the first place, it is well to form some idea beforehand of the kind of subjects to be dealt with in the place visited, as this to some extent decides the best form of apparatus to take for the purpose. Whatever camera is used, it should be one with which the holiday-maker is already familiar. Many disappointments have arisen from the use of new and unfamiliar apparatus specially bought for the occasion. Even the usual brand of plates should be adhered to, and it is well to take a full and reliable supply of them rather than depend on local purchases.

Some workers make a point of developing their plates from day to day as they are exposed. This certainly indicates enthusiasm, but it demands a considerable encroachment on the holiday leisure, and, as a rule, the results suffer on account of the lack of home facilities for the work. If all the exposures are carefully timed, with the aid of a meter when necessary, it is pretty safe to defer development. In that case the exposed plates may be re-packed, carefully tied up, in the original boxes. They should be placed film to film, with cardboard separators or plain tissue paper (not printed matter) interposed. At the same time it is advisable to make occasional exposures in duplicate and develop one of the plates. This can easily be done with the aid of developers ready prepared in some small, handy form, "tabloid" or otherwise, its main object being to ascertain that no unsuspected defect has developed in the shutter or some other part of the apparatus in use. When roll film is being used it is equally advisable to develop an occasional strip.

HOME PORTRAITURE (See "Portraiture.")

HOMOCENTRIC LENS

A name applied by Ross to two distinct types of lens, one being an "air-space" anastigmat, and the other a cemented lens of the Goerz double anastigmat type. The former is made in four intensities— $f/4.5$, $f/5.6$, $f/6.3$, and $f/8$;

and the latter in one intensity— $f/6.8$. The chromatic correction of these lenses is excellent, and they are therefore well adapted for colour photography.

HOMOCOL (Fr., *Homocol*; Ger., *Homokol*)

A sensitising dye of good green sensitiveness, used for bathing plates or adding to emulsion for colour work. It is one of the isocyanine series. Collodion emulsion, sensitised with it, keeps well, and shows extremely clear working qualities. It yields an emulsion of only moderate speed.

HOMOGENEOUS IMMERSION OBJECTIVES

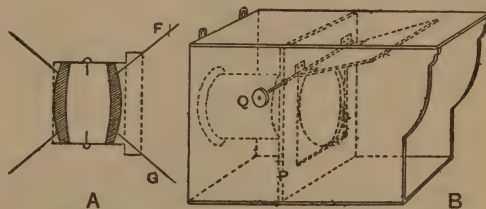
These are described under the heading "Objective."

HONEY PROCESS

Honey was used in one of the methods for preparing albumen plates, but it was more widely used in the early days of collodion plates for the purpose of keeping them moist. The use of honey was advocated in 1854 by George Shadbolt and Maxwell Lyte, who independently discovered its usefulness. The plate was coated with a solution of honey after sensitising, and washed off before development; it kept the plate moist and prevented the crystallisation of silver. Plates prepared with honey needed double the exposure of wet plates, but they could be kept several days before sensitising and exposing, and also between exposing and development. The sticky coating was a serious drawback, as it attracted dust.

HOOD, LENS (Fr., *Parasoleil*; Ger., *Sonnenblende*)

The front projecting rim of the lens tube or mount. A certain degree of such projection is useful, serving to exclude unnecessary light, but the hood should not be deep enough to cut off any of the image. Thus, in diagram A, the outer rays FG proceeding from the object barely clear the hood, and it is evident that if this were the slightest degree deeper some of the marginal rays would be stopped. Hand-



Diagrams Showing Principle of Lens Hood

camera lenses now tend to go to the opposite extreme by having no hood at all, so as to facilitate portability; in consequence, flare becomes probable, and the brilliancy of the image is likely to suffer. Collapsible hoods are manufactured to fit on the lens in hand cameras and other apparatus. The use of an extended hood is especially necessary in telephoto work.

Another kind of hood consists of a blackened wooden or cardboard tube made to fit at the

front of a studio camera, as illustrated at B. The partition P, which comes before the lens, has an opening covered by a hinged shutter, which may be raised or lowered by turning the milled head at the end of the rod Q. Such an arrangement, besides affording a convenient means of exposure, greatly adds to the clearness and freedom from fog of the negatives, by its complete exclusion of all light except that coming direct from the sitter.

HOOD SHUTTER (Fr., *Obturbateur avant-objectif*; Ger., *Vor-objektiv Verschluss*)

Synonym, before-lens shutter. Any shutter fitting on the hood or front of the lens, as, for example, the flap shutter and the outside type of roller-blind shutter. The term is also applied sometimes to the combination hood and shutter accessory often used with studio cameras, and described in the preceding paragraph.

HORIZON (Fr., *Horizon*; Ger., *Horizont*)

When a camera is level, with the lens centrally opposite the plate, the line of the horizon, if visible, will bisect the picture. This is generally considered a defect, and it is well to avoid it by raising or lowering the lens.

HÜBL'S PLATINUM INTENSIFIER

Used for intensifying weak prints on platino-type paper. The print is immersed for from ten to thirty minutes in a solution of platinum perchloride and sodium formate, the platinum being slowly reduced and deposited upon the small particles already present. The formula advised is:—

A. Platinum perchloride . . .	5 grs.	2'3 g.
Water	$\frac{1}{2}$ oz.	100 ccs.
B. Sodium formate	25 grs.	11'5 g.
Water	$\frac{1}{2}$ oz.	100 ccs.

Add A and B to 30 oz. of water. Immerse the print, and when sufficiently dense wash well. Hübl has further suggested a method (*which see*, under heading "Platinotype Process") of obtaining tones between a slate grey and a bright blue.

HÜBL'S THREE-COLOUR PROCESS

The ordinary method of tricolour photography has been dealt with at considerable length, theoretically and practically, and with great exactness, by Baron von Hübl in his work "Three Colour Photography."

HUGHES, CORNELIUS JABEZ

Born 1819; died 1884. After an extensive business experience he became (1862) the official photographer to Queen Victoria. He was an authority on carbon work. His best known book is "Principles and Practice of Photography."

HUNT, ROBERT

Born 1806; died 1887. The most copious writer on photography in its earlier period. In 1844 he published "Researches on Light," in which he was assisted by Sir John Herschel; and, in 1851, "Photography"; in 1850 he compiled a history of photography for the British Association. In 1844 he discovered the developing powers of iron protosulphate, and later made

photographic experiments with the salts of chromium, nickel, lead, manganese, copper, iron, mercury, gold, silver, and platinum. He was, in 1853, one of the founders of the (now) Royal Photographic Society and a member of its first council.

HUNT'S COLOUR PROCESS

Robert Hunt in 1844 published many interesting experiments on the action of the spectrum and coloured lights on silver chloride ("Researches on Light," 1844; "Researches on Light in its Chemical Reactions," 1854), thus following in the footsteps of Seebeck and Herschel.

HURTER AND DRIFFIELD, OR H. & D. SYSTEM

A system of determining the sensitiveness or speed of plates, suggested in 1890 by Hurter and Driffield, and based on the measurement of a series of densities instead of a single one. (*See* "Plate Testing.")

HUSNIK'S PROCESS (*See* "Leimtype.")

HUYGHENIAN EYEPIECE (*See* "Eyepiece.")

HYALOGRAPHY (Fr. and Ger., *Hyalographie*)

Synonym, hyalophotography. Photographic etching on glass. Rozsnyay's method (1875) is much more elaborate than that of Duchochois, and according to the latter, paper is coated with a solution of 100 grs. each of sugar, gum arabic, and ammonium bichromate in 2 oz. of water. The dried plate is exposed under a positive transparency and dusted with finely-powdered bitumen. The "developed" image is transferred to a warm glass, which softens the bitumen and causes it to adhere. The paper is soaked off, the glass dried, and etching done with hydrofluoric acid vapour.

Photo-hyalographs have been used both decoratively and for printing from in the press.

HYALOTYPES

The name by which albumen transparency positive pictures upon glass, in the form of lantern slides, were originally known. They were introduced into England by Messrs. Langenheim, of Philadelphia, and they were known in England as "Crystalotypes" (*which see*).

HYDRAMINE (Fr. and Ger., *Hydramin*)

$C_6H_4(OH)_2(NH_2)_2$ C_6H_4 . Molecular weight, 218. Solubilities, 1 in 500 cold water, 1 in 20 hot water, 1 in 15 hot alcohol, readily dissolved by caustic alkalis. It occurs as white scales, and is obtained as the addition product of one molecule of hydroquinone with one of paraphenylenediamine. It was introduced by Lumière and Seyewetz as a developer, which works best with caustic lithia:—

Hydramine	44 grs.	5 g.
Sodium sulphite	264 "	32 "
Caustic lithia	26 "	3 "
Distilled water to	20 oz.	1,000 ccs.

HYDRATES (Fr., *Hydrates*; Ger., *Hydrate*)

Salts in which a metal replaces one of the atoms of hydrogen in water. (*See* "Caustic.")

HYDRAZINE (Fr., *Hydrazine*; Ger., *Hydrazin*)

Synonym, diamidogen or diamine. NH_2NH_2 . Molecular weight, 32. This was proved to consist of a very faint developer in an alkaline solution, but neither it nor its organic derivatives are practically used. Some of its compounds have lately been suggested as an addition to haloid emulsions without free silver, in order to obtain intense, vigorous images.

HYDROBROMIC ACID (Fr., *Acide bromhydrique*; Ger., *Bromwasserstoffsäure*)

Synonyms, bromhydric acid, hydrogen bromide. HBr . Molecular weight, 81. It is a clear, colourless, or faintly yellow liquid, an aqueous solution of the gas HBr , of which it usually contains 40 per cent. It is occasionally used in 10 per cent. solution as an addition to emulsions.

HYDROCHLORIC ACID (Fr., *Acide chlorhydrique*; Ger., *Chlorwasserstoffsäure*)

Synonyms, chlorhydric or muriatic acid, hydrogen chloride. HCl . Molecular weight, 36.5. Miscible in all proportions with alcohol and water. It is a clear, colourless, fuming liquid, containing about 37 per cent. of the gas HCl . It is very poisonous, the antidotes being magnesia, alkaline carbonates, albumen and ice. It is also a painful escharotic; that is, it burns the skin. The worker should avoid breathing the fumes. It is used for acidulating the alum bath, for removing stains, and to remove the soluble iron salts from platinum prints after development. The impure acid, which is of a strong yellow colour, is known as spirit of salt, and is not used photographically except for cleaning dishes, etc., work which it does excellently.

HYDROFLUORIC ACID (Fr., *Acide fluorhydrique*; Ger., *Fluorwasserstoffsäure*)

Synonyms, fluoric acid, fluorhydric acid, and hydrogen fluoride. HF . Molecular weight, 20. A very dangerous acid in use, as it attacks glass, porcelain, cork, wood; also the nails and skin of the user. It must be kept in indiarubber bottles. The commercial acid is an aqueous solution of the gaseous acid. Practically its sole use in photography is for stripping films from glass plates; but on account of its dangerous nature, the use of potassium fluoride or sodium fluoride has been recommended instead, inasmuch as when an acid is added to either of these, hydrofluoric acid is set free. The negatives should be soaked in a 2 to 3 per cent. solution of the fluoride, rinsed, and then immersed in a hydrochloric acid solution of similar strength.

HYDROFLUOSILICIC ACID

Synonym, fluosilicic acid. H_2SiF_6 . Molecular weight, 144. The product obtained by acting on silicon fluoride with water; it gives off acid fumes. It is used for the surface etching of aluminium plates in lithography.

HYDROGEN (Fr., *Hydrogène*; Ger., *Wasserstoff*)

H. Molecular weight, 1. A colourless, odourless gas prepared by the action of metals on water in the presence of acids or alkalis. Its only photographic use is when mixed or burnt with oxygen for the limelight. Nascent hydro-

gen—that is, when freshly generated—is an extremely energetic reducer. It is sometimes used to reduce the silver haloid residues, and is then formed by acidulating with sulphuric acid and immersing strips of zinc or magnesium, when metallic silver is deposited as a grey powder.

HYDROGEN DIOXIDE (See "Hydrogen Peroxide.")

HYDROGEN FLUORIDE (See "Hydrofluoric Acid.")

HYDROGEN LINES

The Fraunhofer lines given out by glowing or incandescent hydrogen gas generally under reduced pressure in a vacuum tube. They are frequently used for the calibration of spectrometers, to determine the refractive index of glass and scaling spectrograms. The visible ones are the first four in the following table:—

H α	(C) ..	6562.1	Orange red.
H β	(F) ..	4860.7	Bright blue.
H γ	..	4339.5	Deep blue.
H δ	(h) ..	4101.2	Violet.
H ϵ	..	3969.2	
H ζ	..	3888.1	
H η	..	3834.9	
H θ	..	3797.3	
H ι	..	3769.9	
H κ	..	3750.2	
H λ	..	3734.1	
H μ	..	3721.1	
H ν	..	3711.2	

The first column gives the usual scientific method of naming the lines—that is, the hydrogen or H alpha; the second gives Fraunhofer's letters, the third the wave-lengths, and the fourth the colour of the line. A great many other lines have also recently been discovered as belonging to hydrogen, particularly in the ultra-violet.

HYDROGEN PEROXIDE (Fr., *Péroxyde d'hydrogène, Eau oxygénée*; Ger., *Wasserstoffperoxyd*)

Synonyms, hydrogen dioxide, hydroxyl, perhydrol. H_2O_2 . Molecular weight, 34. Miscible in all proportions with water or alcohol. A colourless liquid with slightly acid taste, foaming in the mouth, prepared by the action of dilute sulphuric acid on barium peroxide. The commercial preparations are 3 per cent., corresponding to ten volumes of available oxygen, and 30 per cent. solutions, corresponding to 100 per cent. by volume. It should be kept cool and in the dark. It has been suggested as a "hypo"-eliminator; when rendered alkaline it is a weak developer. Finely divided silver and platinum act as catalysts on it and decompose it into water and oxygen. (See "Catatype.") To hydrogen peroxide has been ascribed the peculiar effect of wood, resins, etc., on dry plates.

HYDROGEN SODA CARBONATE (See "Sodium Bicarbonate.")

HYDROGEN SULPHATE (See "Sulphuric Acid.")

HYDROGEN SULPHIDE (Fr., *Hydrogène sulfuré*; Ger., *Schwefelwasserstoff*)

Synonym, sulphuretted hydrogen, hydrosulphuric acid. H_2S . Molecular weight, 34. A colourless gas, with extremely unpleasant smell; it is usually obtained by the action of an acid on ferrous sulphide. It is occasionally used to precipitate silver from old fixing baths.

HYDROMETER

An instrument for determining the specific gravity of a liquid; used by floating it in the liquid which is contained in a tall glass cylinder. Twaddell hydrometers are adjusted for certain densities, and the degrees ($^{\circ}Tw.$) are converted into specific gravities by multiplying by .005 and adding 1. In the Beaumé hydrometer system ($^{\circ}B.$), for liquids heavier than water, 0° equals a specific gravity of 1; 1° equals 1.007 sp. gr.; 2° equal 1.013; 3° equal 1.02; and so on. For liquids lighter than water, 10° equal 1 sp. gr., and for every rise of 1 in the degrees there is a drop in the specific gravity of about .005.

In process work, the Beaumé hydrometer is universally used by copper etchers for measuring the strength of the ferric perchloride solution. An instrument reading to 50° is the most convenient, as the density of the solution does not exceed 45° , and is more generally between 30° and 40° . The test is usually made in a tall and narrow glass jar made for the purpose.

HYDROQUINONE (Fr., *Hydroquinone*; Ger., *Hydrochinon*)

A developer, known also as hydrokinone, hydrochinone, and quinol. The use of hydroquinone was suggested by Sir William Abney in 1880, but it was not possible to bring it into general use at that date owing to its expense. Since then, however, manufacturers have been able to produce it very cheaply. It occurs in greyish-white or yellow prismatic needles, which darken on exposure to light, and in chemical composition it is allied to pyrogallol, which is trihydroxybenzene, $C_6H_4(OH)_3$, whereas hydroquinone is dihydroxybenzene, $C_6H_4(OH)_2$. Its solubility is 5.8 per cent. in cold water, and about 10 per cent. in hot water. When used alone, particularly if bromide is added as a restrainer, hydroquinone has a tendency to give excessive contrasts, and although an excellent developer, it is more generally used with metol (see "Developers, Mixed"). A solution of hydroquinone is affected by temperature more than is any other developer, and works very slowly—sometimes not at all—when very cold. Hydroquinone may be used in one or two solutions, and the best results are obtained with a caustic alkali.

One-solution Developer (Concentrated)

Hydroquinone . . .	310 grs.	35.5 g.
Sodium sulphite . . .	5 oz.	275 "
Potassium carbonate . . .	8 "	440 "
Hot water to . . .	20 "	1,000 ccs.

The above is a concentrated developer, and for use requires to be diluted with from four to six times the quantity of water. Bromide will be required only in cases of over-exposure. Another

one-solution form, in which sodium carbonate is used, is:—

One-solution Developer (Ready for Use)

Hydroquinone . . .	90 grs.	21 g.
Sodium sulphite . . .	2 oz.	220 "
Sodium carbonate . . .	2 "	220 "
Water to . . .	10 "	1,000 ccs.

Hydroquinone works more quickly with sodium carbonate than with potassium, but the latter is thought to give better gradation.

Messrs. Lumière have recommended the following one-solution (ready for use) formula. It gives absolutely clean negatives of great contrasts, which makes it specially suitable for the reproduction of black-and-white and line drawings, or for obtaining more contrasty positives from thin and weak negatives, care being taken in all cases to keep the exposure somewhat short:—

One-solution Developer (Ready for Use)

Hydroquinone . . .	40 grs.	18.3 g.
Sodium sulphite . . .	400 "	183 "
Formaline . . .	50 drops	20 ccs.
Water . . .	5 oz.	1,000 "

No bromide or alkali is required. Dozens of other formulæ have been given, all more or less based on the above.

Probably the most popular of the two-solution forms—and some scores have been published—is the following:—

Two-solution Developer

A. Hydroquinone . . .	160 grs.	18 g.
Sodium sulphite . . .	2 oz.	100 ccs.
Citric acid . . .	60 grs.	7 g.
Potassium bromide . . .	40 "	4.5 "
Water . . .	20 oz.	1,000 ccs.
B. Sodium hydrate . . .	160 grs.	18 g.
Water . . .	20 oz.	1,000 ccs.

For use, mix together 1 oz. of A, 1 oz. of B, and 2 oz. of water. More or less water may be added as desired, and the more water used the softer will be the result. By using A and B in equal parts without water very hard negatives will be obtained, such as are wanted when copying black-and-white work.

Two-solution formulæ embodying the use of sodium and potassium carbonates are as below:—

Two-solution Developer

A. Hydroquinone . . .	$\frac{1}{2}$ oz.	27.5 g.
Sodium sulphite . . .	2 "	110 "
Water to . . .	20 "	1,000 ccs.
B. Sodium carbonate . . .	$1\frac{1}{4}$ "	69 g.
Water . . .	20 "	1,000 ccs.

Take equal parts of each. 1 oz. of potassium carbonate may replace the $1\frac{1}{4}$ oz. of sodium carbonate in the B solution.

Prof. Lainer has published many useful concentrated two-solution formulæ, five of which are given on the next page, and in order to economise space the quantities are given in "parts," but to those unaccustomed to the "parts" system it may be useful to know that if the solids are weighed in grains and the liquids in minims (480 to the ounce), the proportions will be about right.

	No. 1	No. 2	No. 3	No. 4	No. 5
A. Hydroquinone .	10	10	10	10	10
Sodium sulphite .	25	40	30	35	35
Potass. ferricyanide	60	120	90	25	25
Water .	600	900	950	1000	550
B. Potass. hydrate .	50	50	—	50	—
Sodium hydrate .	—	—	30	—	60
Water .	100	100	90	550	550

For use, A and B are mixed together in proportions as follow: No. 1—1 oz. of A, with 24 drops of B; very rapid in action, but inclined to fog. No. 2—1 oz. of A, with 48 drops of B; a rapid developer, and gives strong contrasts. No. 3—1 oz. of A, with 96 drops of B; gives softer negatives. No. 4—1 oz. of A, with 50 to 70 drops of B; slow working. No. 5—Mix in equal parts; a good, normal developer, which works slowly and gives clean negatives.

One drawback to hydroquinone has been understood to be that it cannot be made up in a highly concentrated form, as, for example, a 10 per cent. solution. J. B. B. Wellington, however, as long ago as March, 1889, published the following formula for a 10 per cent. solution:—

A. Hydroquinone .	1 oz.	110 g.
Methylated spirit	3½ "	350 ccs
Sulphurous acid .	3½ "	350 "
Water to .	10 "	1,000 "
B. Sodium hydrate .	1 oz.	110 g.
Sodium sulphite .	1 "	110 "
Water to .	10 "	1,000 ccs.

For use, add 1 drm. each of A and B to 2½ oz. of water. In the above formula the methylated spirit is used to dissolve the hydroquinone and the sulphurous acid to prevent oxidation.

Hydroquinone may be used again and again for several negatives without fear of staining; but ultimately it gets into a condition in which it stains badly. It keeps well in solution. It should always be dissolved after the sodium sulphite.

In process work, hydroquinone is regarded as the most useful developer for dry plates and collodion emulsion. For the former it is used either alone or in conjunction with metol.

HYDROQUINONE INTENSIFIER

This was recommended by Dr. Eder in 1890. The following two solutions are made:—

A. Hydroquinone .	20 grs.	11.5 g.
Citric acid .	12 "	7 "
Water (distilled) .	4 oz.	1,000 ccs.
B. Water (distilled) .	1 oz.	275 g.
Silver nitrate .	16 grs.	92 "

Mix 3 oz. of A with 1 oz. of B, and immerse the well-fixed and washed negative until dense enough; finally wash.

HYDROQUINONE WITH METOL (See "Developers, Mixed," and "Metol-hydroquinone.")

HYDROSULPHITES, DEVELOPMENT WITH

Jules Breton experimented in 1890 with a rather intense developer, formed of a solution

of sodium hydrosulphite, NaOS_2O_3 , mixed with double sulphite of sodium and of zinc. There is some trouble with deposits, but it is possible to obtain dry plate negatives of a fine black, if care is taken.

HYDROTYPE

A reversed collotype process chiefly due to Cros. It has been used in a modified form for colour printing. A gelatine image is made to absorb dyes in proportion to the action of light, so that when paper is brought into contact with the stained plate whilst damp an image is obtained from the dye.

HYDROXYL (See "Hydrogen Peroxide.")

HYDROXYL CARBON COMPOUNDS

Carbohydrates containing the hydroxyl group OH for a hydrogen atom.

HYDROXYLAMINE (See "Hydroxylamine Hydrochloride")

HYDROXYLAMINE HYDROCHLORIDE
(Fr., *Chlorhydrate d'hydroxylamine*; Ger., *Salzaures Hydroxylamin*)

$\text{NH}_2\text{OH.HCl}$. Molecular weight, 69.5. Soluble in water and alcohol. It takes the form of colourless crystals, and can be prepared by reducing ethyl nitrate with tin and hydrochloric acid and chlorising. Both hydroxylamine and the hydrochloride are vigorous developers when rendered alkaline with caustic alkalis, but they are of no practical value as nitrogen gas is evolved during development, which either pits the film all over or strips it from the glass.

HYDROXYTRICARBOXYLIC ACID (See "Carboxylic Acids.")

HYGIENE IN PHOTOGRAPHY

Photography does not now involve many risks to health, but it is necessary to remember that there are still a few chemicals used which injure the worker's hands if they come in contact with them, and of which the fumes become dangerous if inhaled. Should the dark-room be insufficiently ventilated the atmosphere will become stuffy and cause headaches; and, of course, when strong-smelling chemicals are used—as ammonia, sodium sulphide, etc.—good ventilation is all the more important.

Many users of a red light find that it makes their eyes ache if employed for any length of time, and when this happens a weak solution of boracic acid should be made up (8 grs. to 1 oz. of water), and this should be mixed with an equal volume of hot water and applied to the eyes with a clean handkerchief or sponge.

When the daguerreotype process is worked by experimentalists, particular care should be taken not to inhale the fumes from the mercury, as they are most dangerous. The fumes from collodion (ether, really) and ammonia involve but slight risk to the health, but they affect the eyes. Should ammonia be found to affect the worker, he should sniff weak acetic acid or ordinary brown vinegar, and he may sip a little of the latter with helpful results.

The fumes from all acids, particularly hydro-

fluoric, and from potassium cyanide are more troublesome; when these substances are used, the dark-room must be well ventilated, otherwise bad headaches will occur and the membranes of the eyes, nose, and throat be affected. The best remedy for acid fumes is to sniff weak ammonia.

Some chemicals injure the skin and the clothes if they come in contact; particularly is this the case with nitric acid, which burns severely. The remedy is to apply a strong solution of common washing soda or weak ammonia, or, in fact, any alkali. Potassium bichromate affects the skin at times, and the subject will be found dealt with under "Bichromate Disease." Platinum solutions are not often looked upon as dangerous, but when using them or large quantities of platinum paper some workers suffer from a skin disease and also nasal catarrh. A warm and weak solution of salt and water sniffed up the nose occasionally will, as a rule, cure the catarrh, while the same solution of salt and water will soothe and possibly quite cure the skin trouble. Hydroquinone, amidol, and metol developers (more particularly the last named) affect some workers, and when they do the treatment as prescribed under "Bichromate Disease" may be tried, or the following ointment, which any chemist will make up, used:—

Ichthyol	1 part
Lanoline	2 parts
White vaseline	3 "
Boric acid	20 "

All developers are apt to affect the skin more or less, and, after developing, the hands should always be well washed with warm water and a good soap of the carbolic variety. Developer-stained fingernails may be cleaned by rubbing with ink eraser; or in troublesome cases they may be rubbed with lemon juice or ammonium persulphate crystals. When using developers that stain, workers should wear rubber finger-stalls or gloves. To keep the hands white and soft they should be rubbed with new milk previous to developing. Should an irritation be felt after using a mercury and ammonia intensifier, the remedy is to wash the hands with warm water, dab—not rub—dry with a soft towel, and rub in the following soothing mixture:—

Glycerine	4 drms.	17 ccs.
Carbolic acid	1 "	4 "
Alcohol	5 oz.	1,000 "

HYGROMETER (Fr., *Hygromètre*; Ger., *Hygrometer*)

An instrument for measuring the amount of moisture in the atmosphere, occasionally used in plate and paper factories and in collotype printing rooms.

HYPERFOCAL DISTANCE

Assuming an object at an infinite distance from a camera to be sharply focused, the object is next brought nearer to the camera, and the distance at which the image visibly loses its sharpness is the hyperfocal distance. Assuming the degree of permissible unsharpness to be a circle of confusion $\frac{1}{16}$ in. in diameter, the hyperfocal distance in inches for any given lens at any given aperture is arrived at in the follow-

ing way. Multiply the focal length by itself, multiply the product by 100, and divide the result by the *f* number. The focal length being

$$5 \text{ in. and the aperture } f/8, \frac{5 \times 5 \times 100}{8} = \frac{2500}{8} = 312\frac{1}{2} \text{ in.} = \text{about } 26 \text{ ft.}$$

The hyperfocal distance is sometimes called the "fixed focus," and it becomes shorter as the aperture is reduced; in the case of the 5-in. lens, it is about 13 ft. at *f*/16 and about 6½ ft. at *f*/32.

HYPERGON LENS

A wide-angle, double anastigmat lens, consisting of two very thin single semiglobular lenses. The largest aperture is *f*/22, and the angle included about 135°, the diagonal of the plate covered being five times the focal length of the lens. In order to equalise the illumination over this large field, outside the lens is fixed a revolving star diaphragm, which, during part of the exposure, is made to revolve by a jet of air and then dropped out of the way. The hypergon is uncorrected for chromatic aberration.

HYPERSTEREOSCOPY

The making of stereoscopic views of distant objects from two separate and widely apart stations, with ordinary camera and lens.

HYPERTELESTEREOSCOPY

Hyperstereoscopy with telephoto lenses.

"HYPO"

The abbreviated and popular name for sodium hyposulphite (*which see*). For "hypo" fixing baths, see "Fixing," "Acid Fixing Bath," and "Alkaline Fixing Bath."

"HYPO" IN DEVELOPER

The addition of very small quantities of "hypo" to certain developers is sometimes advised; with the ferrous oxalate it acts as an "accelerator," because it decomposes the ferric oxalate formed, which acts as a restrainer.

"HYPO" ELIMINATORS

Various chemicals have been suggested from time to time for the purpose of curtailing the washing of negatives and prints by chemically destroying the last traces of "hypo," such as hypochlorite of zinc, eau de Javelle, iodides, alum, lead acetate, hydrogen peroxide, potassium permanganate, etc., and recently several of the persulphates and percarbonates have been introduced under fancy names. Many if not all of these merely convert the hyposulphite into tetrathionate. It must not be forgotten that the hyposulphites of silver have to be dealt with as well as the hyposulphite of soda, and these are not necessarily more soluble. If rapidity of output regardless of permanency is the result, then the use of such chemical agents is warranted, but considering that all possible traces of the hyposulphites can be removed by an hour's washing correctly performed, it is an open question whether such means are justified.

"HYPO" STAINS (*See* "Stains, Removing.")

"HYPO"-ALUM TONING (*See* "Alum-'hypo' Toning.")

I

ICELAND MOSS

A moss or lichen found in the Arctic regions. It forms, when boiled in water, a jelly which has a few photographic uses, notably as a vehicle for sensitive salts when sensitising fabrics. Carrageen (Irish moss) has much the same properties.

In process work, the gelatinous nature of this substance has suggested its use as a substitute for fish-glue in the enamel process of photo-etching, but it was not found to have any advantages over fish-glue.

ICHTHYOCOL, OR ICHTHYOCOLLA

Fish-glue or isinglass.

ICHTHYOL

A bituminous substance which emulsifies quite easily with water, and can be added to collotype emulsions, with the object of strengthening the coating. Dissolved in a mixture of ether and alcohol, it leaves by evaporation a granular layer similar to resin grain or bitumen grain. Dissolved with an equal weight of water it forms an ink which has the property of attracting greasy ink and repelling water, so that it may be used for lithographic purposes.

ICONOMETER (Fr., *Iconomètre*; Ger., *Ikonometer*)

A view meter giving a direct image and enabling the best standpoint with a given lens to be ascertained without first setting up the camera. One form is a rectangular open frame of watch-spring set upright on a horizontal rod graduated in centimetres. On placing the eye at a sight at the zero end of the rod, the exact view given by the lens with the camera in that position is seen through the frame. The latter is movable on the rod by means of a slide, for use with lenses of different focal lengths. The rod itself is hollow, and when the instrument is not in use the frame can be folded up and inserted inside it, together with the sight, it being then placed in the pocket like a pencil.

ILLUMINANTS, LANTERN (See "Optical Lantern Illuminants.")

ILLUMINATION, DARK-ROOM (See "Dark-room Illumination.")

ILLUMINATION, INTENSITY OF (Fr., *Intensité d'illumination*; Ger., *Lichtstärke*)

The visual strength or brightness of light. The intensity of light passing through a lens or pin-hole is proportional to the area of the opening through which it is admitted, the opening, in the case of a lens, being the diaphragm or stop. It is also inversely proportional to

the distance from the source of light of the surface receiving it, since the light obviously spreads out and becomes attenuated. The rule is, the intensity of illumination is inversely proportional to the square of the distance, but photographically this rule tends to break down if carried beyond certain moderate limits. The intensity is weakened when the light is made to cover a larger surface, as, for instance, if it strikes the plate at an angle instead of perpendicularly, which may happen when using the swing-back or swing-front. The margins of the view given by a wide-angle lens are often not so well lit as the central portion, because the marginal rays reach the plate at an acute angle. Printing frames should be placed square to the light; if inclined, not only is the light spread and weakened, but much lost by reflection.

IMAGE, [LATENT OR INVISIBLE (See "Latent Image.")

IMMERSION LENS (See "Objective.")

IMOGEN SULPHITE (Fr., *Imogène sulfite*; Ger., *Imogen sulfite*)

A developer needing only a saturated solution of sodium carbonate to make it active. It occurs in a pinkish white powder which keeps well, both dry and in solution, owing to there being combined with it the necessary amount of preservative; it yields negatives of a good warm-black colour. Potassium bromide in small quantities acts only as a preventive of fog; larger quantities have a stronger restraining action and increase contrast. For correct exposures no bromide is required, but for over-exposure a 10 per cent. solution may be used. The imogen sulphite developer is made up in two solutions, the makers' instructions being as follow:—

A. Imogen sulphite 1 oz., warm water 12 oz.

B. A cold saturated solution of soda carbonate.

For correct exposures take of solution A 2 parts, and B 1 part. Add water, and use more of B for under-exposures. For bromide paper, the above solutions should be diluted with an equal amount of water, bromide being added. Fix in an acid fixing-bath.

IMPERIAL

A size of photographic mount which varies between $6\frac{1}{8}$ in. by 10 in. and $7\frac{1}{8}$ in. by $9\frac{1}{8}$ in.

IMPRESSIONISM

This term is often used vaguely and with great differences of meaning. The broad idea implied is that a subject is rendered as it first strikes the eye; as it appears at one particular time; or so as to convey, first and foremost, the general

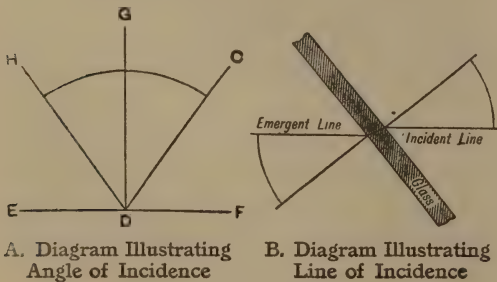
mental impression created by its appearance under certain conditions. Now a hurried impression would be more or less general, and lacking in such detail as would be noted after prolonged or frequent examination. Hence the idea that impressionism means indistinctness, or involves "fuzziness." This is not necessarily so. The impression, or mental effect, might be one of brilliance, sharpness, and wealth of detail.

To take an example. A photographer's impression of a church tower might be that it was one white, gleaming mass, standing out vividly from all its surroundings. To convey this impression he would probably emphasise the darkness of the sky behind it, and suppress detail and light everywhere but in the tower itself. Under other conditions the same tower might convey the impression of a solid silhouette standing forth boldly against a brilliant sky. In neither case would the tower be rendered with the realism that an architect would require as a record of its design. In each case it would be treated so as to suggest as far as possible the particular impression it made at the time. This is, of course, a simple case to take. Carried farther, the desire for impressionistic renderings leads to the adoption of all sorts of devices to modify, control, and emphasise actual photographic results.

INCANDESCENT LIGHT (See "Artificial Light.")

INCIDENCE, ANGLE OF (Fr., *Angle d'incidence*; Ger., *Einfallwinkel*)

The angle which a ray of light falling on a flat surface forms with the perpendicular to that surface, or to the tangent if the latter is curved. Thus, if a ray of light CD strikes a plane surface EF at the point D , as shown by diagram A, the angle CDG made by the ray CD with DG , a perpendicular to EF drawn from the point D , is the angle of incidence. The line CD is called the line of incidence. If the plane surface is a mirror, the light will be reflected from D in the



A. Diagram Illustrating Angle of Incidence

B. Diagram Illustrating Line of Incidence

direction DH . The angle HDC , formed by the perpendicular with the line of departure of the light, is termed the angle of reflection, and is always equal to the angle of incidence. When the line of incidence is itself perpendicular to the receiving surface, the light is reflected back along its original course, or in the case of a transparent body passes straight through without refraction. When a ray of light strikes a transparent surface

of different density to that in which it was previously moving it is refracted. Provided the transparent body has parallel sides, as, for instance, a sheet of glass, the ray will emerge after refraction in a direction parallel with the line of incidence, and at the same angle as the angle of incidence, as shown at B. (See also "Reflection" and "Refraction.")

INCIDENCE, LINE OF (Fr., *Ligne d'incidence*; Ger., *Einfall Linie*)

The straight line taken by a ray of light proceeding towards any surface, whether it strike the latter obliquely or at a right angle. (See also "Incidence, Angle of.")

INDEX OF REFRACTION (See "Refraction.")

INDIA TINT MOUNT

A mount that has pasted down on it a sheet of thin tinted paper slightly larger than the print which it is to carry. The mounted print thus shows a narrow margin of one tint with a wider border of another. A cheap imitation is made by printing the central tint by lithography.

INDIAN INK (Fr., *Encre de Chine*; Ger., *Tusche*)

Indian ink is only so called; actually it is Chinese ink, which formerly was available only in the form of cakes or sticks which had to be rubbed up with water for use, but which is now obtainable in the prepared liquid form, waterproof if desired. It is frequently used for painting out backgrounds, etc., in negatives, so that they appear white in the print. It is inferior to Indian red for this purpose, as it has a great tendency to crack badly after drying, and so render the work valueless.

To prevent work done in Indian ink running when touched with water, a tiny piece of potassium bichromate should be rubbed up with each saucerful.

Indian ink is not now used so much as formerly for process drawings, the modern waterproof inks having largely superseded it.

INDIAN RED

An opaque water colour composed principally of a natural earth. It is used for painting out backgrounds or portions of a negative that are to show as white in the print. The moist form, in tubes, is preferable, and the pigment should be applied to the film very thickly. It has no tendency to crack after drying.

INDIARUBBER (Fr., *Caoutchouc*; Ger., *Kautschuk*)

Synonyms, caoutchouc, gum elastic, rubber. Insoluble in water and alcohol, soluble in carbon disulphide, chloroform, benzene, etc. A natural product, the coagulated juice of various plants belonging to the natural order *Euphorbiaceæ*. It occurs in brownish black cakes, balls or hollow-shaped pieces. It is very elastic and of characteristic odour. When heated with 10 per cent. of sulphur it becomes vulcanised. For photographic purposes, the pure washed and masticated rubber, not the vulcanised rubber, should be used. It is employed as an edging for

collodion plates and as a mountant. The most satisfactory solvent is carbon disulphide with 5 per cent. of absolute alcohol, in which the rubber, cut in small pieces, should be allowed to stand with agitation till dissolved. In order to save the trouble of making, the ordinary cycle tyre cement may be used and thinned down with disulphide or chloroform. The great drawback to its use as a mountant is that the rubber perishes in time, and the print leaves the mount.

In process work, a solution of indiarubber in benzole of 2 per cent. strength is used in stripping wet collodion films. The collodion negative is flowed with the rubber solution, and when this is dry it is again flowed with stripping collodion. The rubber solution prevents the solvents of the stripping collodion reaching the original collodion film, and at the same time increases the flexibility and toughness of the film.

Indiarubber solution is used in the collotype process for attaching to the negative the tinfoil used for masking.

In aerograph retouching, some workers use indiarubber solution for stopping-out certain portions of the print on which the aerograph spray is not wanted. After the spraying is done the rubber film easily peels off by rubbing with the finger-tip, and carries with it any spray that has overstepped the boundaries of the stopping-out medium.

INDIARUBBER CLOTH (Fr., *Drap de caoutchouc*; Ger., *Kautschukzeug*)

Thin sheet vulcanised rubber, or fabric coated on both sides with a thin film of the latter. Indiarubber focusing cloths are of value in protecting the camera during bad weather. Cut pieces of rubber fabric or sheet rubber pads are employed to lay over prints when squeegeeing, and are placed at the back of platinotype paper in the frame when printing, to protect it from damp.

INDIARUBBER MOUNTANT (See "Indiarubber" and "Mountants.")

INDICATOR (See "Exposure Indicator," "Print Indicator," etc.)

INDIGO PRINTING

A process of photographic printing on fabrics by means of a mixture of indigo white, sodium bisulphite, soda, water, and gum. The image is developed in a caustic soda solution.

INDOOR PHOTOGRAPHY

Apart from actual studio work, a good deal of photography can be done indoors in almost every house, and that without any elaborate or unusual addition to the ordinary outdoor apparatus. Flashlight work comes under a special category. A good deal can also be done nowadays with the ordinary domestic means of artificial illumination. But still more can be done by daylight. Flowers, fruit, and all kinds of still-life subjects can be most effectively and conveniently dealt with indoors, and portrait and figure studies provide a wide and varied field of operations. Except in special cases, the ordinary window lighting requires some modification before it is

suitable. It is generally necessary not only to use blinds to shut out part of the light and control the direction of what is admitted, but to have a diffuser to soften it and make it even. This may be white muslin or buttercloth, which it is generally convenient to stretch on a light wooden frame. It is also necessary to have a second screen of more opaque fabric to act as a reflector on the shadow side. Considerations of space often compel the use of lenses of somewhat short focus, but every effort should be made to avoid this, especially in the case of work from the figure. Lenses of large aperture are also an advantage, as they not only facilitate focusing in what is frequently a subdued light, but permit of shorter exposures. Suitable backgrounds must also be considered. Sometimes the actual surroundings of the room are appropriate, but one or two plain backgrounds, both light and dark in tone, are almost essential. For still-life studies sheets of paper or cardboard of various colours are useful as backgrounds, and as the lighting is generally from the side it is easy to avoid cast shadows on them.

INDOTINT (Fr. and Ger., *Indotint*)

A photo-mechanical process resembling collotype, invented by Roche, of New York. A copper plate roughened by the sand-blast, to secure adhesion of the sensitised gelatine film, is used instead of the ordinary thick glass plate.

INDUCTION COIL (Fr., *Bobine*; Ger., *Induktionsrolle*)

Induction coils are almost universally employed to produce the high potential currents necessary to excite the vacuum tube in X-ray work. An induction coil consists of three parts entirely insulated from one another. In the centre is the core, a bundle of soft iron wires laid longitudinally. Round this is wound, as on a reel, two layers of stout insulated copper wire to carry the primary current from the public main or accumulators. Round this primary winding, and well insulated from it, is wound the secondary, of very thin insulated copper wire, often many miles in length. Directly the current is switched on through the primary the core becomes magnetised, causing the secondary coil to give out a current which flows in the reverse direction. This induced current is only of momentary duration. A greater though still momentary effect is produced when the current is switched off. In order to produce a rapid and continuous series of shocks or discharges from the secondary coil with which the tube is in circuit, the current through the primary must be interrupted and renewed several hundred times a minute.

This rapid starting and checking of the flow of current through the primary winding, technically known as "making" and "breaking" contact, is automatically accomplished by means of "contact breaks" (*which see*).

INERTIA (Fr., *Inertie*; Ger., *Inertia, Trägheit*)

A term adopted by Hurter and Driffeld to measure the slowness of a plate; the greater the inertia the slower the plate. (See "Plate Testing.")

INFINITE RAYS

Rays emerging from an extremely distant point and consequently practically parallel with one another.

INFINITY

Photographically, a distance beyond which no readjustment of focus is necessary to secure a sharp image of more distant objects. It increases in proportion to the focal length of the lens used. It is expressed on focusing scales by the sign ∞ , the abbreviation INF, and occasionally the initial D (distance).

INFLECTION

Synonymous with "diffraction" (*which see*).

INFRA-RED RAYS (Fr., *Rayons infra-rouge*; Ger., *Ultraviolett Strahlen*)

A vast region of the spectrum lying beyond the red and to which our eyes are not sensitive, but which we are conscious of in the form of heat. Although we cannot see this region we know that it is traversed by absorption lines exactly in the same way as the visible spectrum; they have been detected not only by direct photography by means of a special collodion emulsion (Abney), but also especially by means of the bolometer (*which see*). The absorption lines are indicated by the letters of the Greek alphabet. As most glasses are comparatively opaque to the infra-red rays, spectroscopes for the examination of this region have to be fitted with rock salt or sylvan lenses and prisms, or else transmission diffraction gratings with comparatively wide spacings, these gratings being in many cases made of silver or platinum wire.

INITIAL POWER

In photo-micrography, the initial power of a microscope objective is the magnification which the lens will give without an eyepiece at a distance of 10 in. from its back lens; for example, if the image of an object thrown by the objective upon a screen at 10 in. distance magnifies the object 20 diameters the initial power of the objective would be 20. The initial power of an eyepiece or ocular is the magnification given by the eyepiece itself. The initial power of an objective multiplied by the initial power of the eyepiece gives the total magnifying power of the lenses used.

INK FOR GLASS, PORCELAIN, ETC.

Ink for writing names on glass bottles, porcelain dishes, tins, etc., may be made by dissolving 60 grs. of powdered copal in 1 oz. of oil of lavender made warm, and then mixing the solution, by means of a palette-knife on a stone, with 6 grs. of lampblack and 2 grs. of indigo; if other colours are wanted, vermilion, ochre, etc., may be used. The mixture is applied with a fine camel-hair brush. To make the writing stand out prominently on glass it is advisable first to paint a shield or tablet on the glass, using white bath enamel for the purpose.

A mixture particularly suitable for lantern slides may be made by dissolving 1 drm. of shellac in $\frac{1}{2}$ oz. of methylated spirit; then dissolve $\frac{1}{2}$ drm. of borax in $\frac{1}{2}$ oz. of water. The solutions should be mixed together very slowly,

and if a precipitate forms the mixture should be heated until clear. Enough aniline dye of a suitable colour—methylene blue is generally used—should be added to colour the mixture. This dries quickly and is permanent.

INK FOR LABELS (See "Labels, Water-proof Ink for.")

INK PRINTING

Poitevin's pigment process depends upon three facts: *ferric* chloride renders gelatine insoluble, *ferrous* chloride has not that effect, and light converts the ferric into the ferrous chloride. If paper is coated with gelatine and ferric chloride, printed under a negative, and placed in warm water, the shadow portions (those acted upon by light) are made soluble. Thus a negative is made from a negative and a positive from a positive. 1 oz. of gelatine is soaked in 15 oz. of water, dissolved by heat, and 100 grs. of Indian ink mixed in very thoroughly. Paper is floated on the still warm mixture for three minutes, dried quickly, and immersed in the following sensitive mixture until limp:—

Iron perchloride . . .	1 oz.	110 g.
Tartaric acid . . .	140 grs.	32 "
Water . . .	10 oz.	1,000 ccs.

The paper is dried in the dark, printed under a positive, and developed and fixed simply by washing gently in warm water.

Another method invented by Poitevin is to float plain paper for three minutes on a sensitive mixture prepared as follows:—

Iron perchloride . . .	144 grs.	33 g.
Citric acid . . .	96 "	22 "
Water . . .	10 oz.	1,000 ccs.

The paper is dried quickly in the dark, printed under a positive and developed by immersing in a weak solution of Indian ink in glycerine. The ink will affect only those parts that have not been acted upon by light. The developed print is finally briefly washed and dried.

Most of the photo-lithographic and collotype processes may be described as ink-printing. The sensitised bichromate image is rendered susceptible to printing ink by exposure to light. The Amphitype process, and the Ordoverax processes (*which see*), also show that the iron salts are capable of being made to take up fatty inks.

INK PROCESS

A method of printing by which photographic pictures may be obtained in common writing-ink, sometimes referred to as the gallate of iron process. A sheet of white paper is immersed in a nearly saturated solution of potassium bichromate and dried, being now of a bright yellow colour. It is next placed under a negative and exposed to sunlight, which acts upon the bichromated surface and gives a pale brown picture. When all detail can be seen, wash in plain water for about an hour in order to remove the yellow and superfluous bichromate. This washing serves to fix the print, which should be of a pale yellow colour on a white ground. The print is given a colour and at the same time intensified by immersing for a few minutes in a solution of 5 grs. of iron protosulphate (ferrous

sulphate) in 1 oz. of water; well wash, and place in a moderately strong solution of tannic acid, which will cause tannate of iron (writing-ink) to be deposited, a black image being formed. The difficulties of the process consist in thoroughly eliminating the chromium and ferrous salts, and in obtaining the writing-ink of a good black colour. There are other methods.

INK, WATERPROOF (See "Labels, Waterproof Ink for.")

INK, WHITE

White ink is used on black lantern-slide masks. To prepare it, take a cake of Chinese white water-colour, and rub it up with water by means of a camel-hair brush until of the consistency of ordinary ink. It is put into a pen with the brush and the title written with the pen. A white ink that may be stored in a bottle is made by taking:—

Isinglass	•	•	•	1 oz.	77 g.
Chinese white	•	•	•	1 "	310 "
Methylated spirit	•	•	•	1 drm.	35 ccs.
Water as required.					

Soak the isinglass in 1 oz. of water until soft, heat until dissolved, and rub up with the Chinese white in a hot mortar. Add water until the mixture is of the consistency of ordinary writing-ink. Finally add the methylated spirit and bottle for use. If the ink is to be kept for any length of time, add 2 drops of carbolic acid as a preservative. A passable white ink is made by rubbing up zinc white with gum arabic solution.

INKING-UP

In photo-mechanical processes this term is often used. For instance, in photo-lithography the transfer print after exposure is inked all over with a thin coating of ink, previous to development. The same is done in the case of direct printing on stone or metal. In line photo-etching the print on the zinc is inked-up after exposure by applying all over by means of a composition roller a thin coating of a special kind of transfer ink. The image, after it has been developed on the stone or plate, is often strengthened by keeping the plate moistened with gum water and passing over it a roller charged with lithographic ink, but although this is often spoken of as inking-up it is more correctly called "rolling-up" (*which see*).

INK-PHOTO PROCESS

A photo-mechanical process worked since about 1882 by a London firm. It is understood to be based on a grained image formed in a similar manner to the collotype process, a transfer being taken therefrom and put down on stone for printing in the lithographic manner.

INSECTS, PHOTOGRAPHING

The photographing of insects falls naturally under two heads—namely, photographing living insects, and photographing dead, set specimens. Living insects should be photographed in their natural environment, the caterpillars on their favourite food-plant, the butterfly or moth upon the flower, tree-trunk, wall, or other situation which it most frequents. The most interesting

and valuable results will be obtained by concentrating one's efforts upon one insect at a time, and working to produce a complete set of photographs which will show every stage in its life-history from the egg to the perfect insect. The reflex camera is undoubtedly the best type for photographing living insects, as it enables one to follow and focus the subject up to the instant of making the exposure, and, being fitted with a focal plane shutter, permits the maximum amount of light to reach the plate during exposure. A good lens of large aperture and fairly long focal length should be used, one with a working aperture of $f/4.5$ or $f/6$, and having, for a quarter-plate, a focal length of 7 in. Fast isochromatic plates should always be used.

For photographing dead, set specimens, an ordinary rigid stand camera, having a long extension of bellows, will be most useful; and for all-round purposes a half-plate size will be most convenient, because of its greater bellows extension. The plate-holders can be fitted with adapters to carry quarter-plates, and the front of the camera should have two or three extra lens-panels, so that lenses of varying focal lengths may be used. By this means it is possible to obtain photographs direct of life size, and also of two or three diameters magnification. The set specimen should not be placed upon a drawing-board or similar support, as the shadows cast by the body, legs, and wings of the insect will give a very unpleasant and confusing effect. A good, clear sheet of glass should be used, and the insect can then be pinned on to a tiny piece of cork which will not be large enough to show and which has been cemented in place. A suitable coloured background can be placed eight or ten inches behind the glass, so that no shadow will be cast by the insect.

A notebook record should be kept of all work done in the field, and an entry made of each subject, giving particulars as to the plate used, lens and stop, exposure, lighting, time of day, day of month, result obtained, and any notes of interest concerning the subject itself. F. M-D.

INSENSITIVENESS

Occasionally a plate or film is found to lack in parts the general sensitiveness. This is almost always due to the local action of some desensitiser, generally a metallic impurity, such as iron, etc.

"INSTANTANEOUS" PHOTOGRAPHY

The term "instantaneous" is loosely used in photography, being generally understood to refer to exposures of less than one second. The photographing of ordinary views "instantaneously" was vainly attempted by Daguerre in 1841, and the first authenticated "instantaneous" photograph is that of New York harbour, taken in 1854.

The essential conditions under which "instantaneous" exposures, in order to be successful, must be made are: A good light, an efficient shutter, a suitable lens working at a large aperture, and a rapid plate. For average street work $\frac{1}{16}$ th of a second is quite fast enough; while if objects are moving to or from the camera direct and not at right angles, the exposure may be increased to $\frac{1}{8}$ th of a second. According to the Thornton-Pickard Company, the following rule—

answers for finding the "instantaneous" exposure for a moving object:—The distance of the object from the camera, measured in inches, is divided by the number of yards per hour at which the object is travelling, multiplied by the focus of the lens in inches. The result will be the fraction of a second, which is the longest allowable exposure that does not show movement in the resulting photograph. Below is given a table showing the correct exposure for various moving objects. The table is made out for a distance from the camera 100 times that of the focus of the lens: that is, for a 6-inch focus lens at 50 ft., a 7-in. at 58 ft., etc.

Towards the Camera *At right angles to Camera*
(sec.) (sec.)

Man walking slowly,			
street scenes ..	..	$\frac{1}{15}$	.. $\frac{4}{5}$
Cattle grazing ..	..	$\frac{1}{15}$	.. $\frac{4}{5}$
Boating ..	..	$\frac{1}{20}$	.. $\frac{1}{10}$
Man walking, children			
playing, etc. ..	..	$\frac{1}{50}$	.. $\frac{1}{150}$
Pony and trap, trot-			
ting ..	..	$\frac{1}{100}$	.. $\frac{1}{300}$
Cycling, ordinary	..	$\frac{1}{100}$	.. $\frac{1}{500}$
Man running a race,			
and jumping ..	..	$\frac{1}{100}$	.. $\frac{1}{500}$
Cycle racing ..	..	$\frac{1}{100}$	.. $\frac{1}{500}$
Horse galloping	..	$\frac{1}{80}$	.. $\frac{1}{500}$

If the object is twice the distance, the length of allowable exposure is doubled, and vice versa. (See also "Focal Plane Shutter" and "Hand Camera, Work with.")

INSTANTANEOUS SHUTTER (Fr., *Obturateur instantané*; Ger., *Moment Verschluss*)

Any shutter which, by pressing a trigger, push, lever, or pneumatic ball, will give a rapid exposure lasting only the fraction of a second. A "time and instantaneous shutter" is one that in addition to giving "instantaneous" exposures when required, can be set to remain open for exposures of any length and to close at the will of the operator by a further pressure of the release. (See also "Shutters.")

INTAGLIO PRINTING

Any method of printing in which the lines, dots, grain, or other elements of the engraving are sunk in the plate, so that the depressions are filled with ink for printing, as distinguished from relief plates or blocks where the printing elements are raised and are inked on their surfaces. Thus the old engraving or etching processes, such as mezzotint, aquatint, needle-point etching, copper and steel plate engraving, and the like are intaglio printing processes. Photogravure and heliogravure are also intaglio methods. Of late, the term intaglio printing has come to be applied in a more limited sense to methods of forming a sunk engraving or etching by means of a ruled screen, and the printing of the same by mechanical power. For some years past there have been machines for printing from flat plates, the sunk image being inked and the surface being wiped clean by mechanical arrangements. Such machines have, however, not come into general use, there being almost insuperable

difficulties in efficiently wiping the flat surface. Rotary intaglio printing solves this problem very successfully, and the method has been successfully worked for some years by a Lancaster firm which was the first to carry out the experiments and devise suitable machinery for this work. Their methods are secret, but a number of later experimenters have proceeded on the assumption that a photographic carbon print, which has been also exposed under a ruled screen, is developed on a hollow copper cylinder. The carbon print forms a resist as in the photogravure process, and the image is thereby etched in intaglio. The spaces between the screen lines form minute cells which hold the ink, preventing its being wiped out during the printing operation. The hollow cylinder is placed on a mandrel and mounted in a machine similar to that which is used for wallpaper or calico printing. Under the engraved cylinder is an inking roller working in a trough of thin ink, and feeding the ink into the engraving. Above the engraved cylinder is an impression roller with an elastic covering of blanket or rubber. In contact with the engraved cylinder is a steel knife, called the "doctor," which scrapes the surplus ink quite cleanly from the surface, leaving it in the hollows of the engraving. Paper is fed from a reel, and passes between the impression cylinder and the engraved cylinder, thus receiving a print at every revolution of the latter. Mechanism is provided for delivering and cutting off the prints. The method has been found to present considerable difficulties.

Dr. E. Mertens, of Freiburg, has extended the process to newspaper printing by coupling up the intaglio machine to the ordinary rotary stereo printing machines, so that when the web of paper emerges from the intaglio printing machine it passes into the newspaper rotary to receive the impression of the text formes.

The rotary intaglio method has been applied to colour printing with very fine results.

INTAGLIOTYPE

A process for obtaining intaglio plates, patented in 1893 by Joseph Hines. A bichromated gelatine film on a metal plate is exposed under a negative and developed with heated sulphate of iron solution until the lines are clear. The plate is then mounted and printed from.

INTENSE NEGATIVES

A negative may be very dense from two or three causes. A plate that is considerably overexposed and then developed normally will yield a very dense negative that takes so long to print as to be quite useless. If the exposure is correct, a plate can only be too dense through excessive or incorrect development. If the shadows are strongly veiled, the cause is excessive exposure; and the best treatment is the "hypo" and ferricyanide reducer. If the shadows are moderately clear, the cause is excessive development, and the ammonium persulphate reducer should be employed. (See also "Reducing Negatives.")

A negative may be too intense as the result of intensification. If mercury has been used for intensifying, the effect can always be reduced by a weak solution of "hypo."



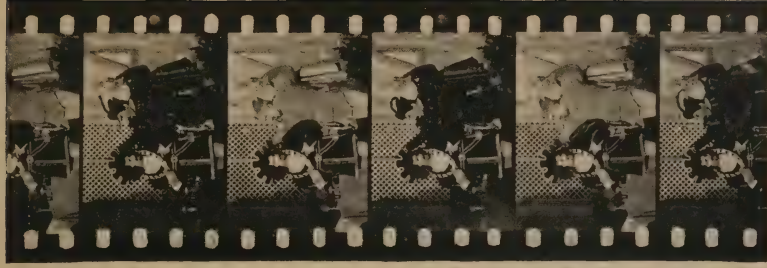
ORDINARY NEGATIVE
FILM



ORDINARY POSITIVE
FILM



KINEMACOLOR
NEGATIVE FILM
A. Through Green Filter



KINEMACOLOR
POSITIVE FILM
B. Through Red Filter

KINEMATOGRAPH FILMS

INTENSIFICATION OF NEGATIVES (Fr., *Renforcement*; Ger., *Verstärkung*)

A process whereby density or contrast is increased. Intensification processes in common use vary in the degree of strengthening rather than in their character; with slight exceptions they do not change the gradation, but strengthen all parts of the scale in a uniform ratio. The exceptions are some of the processes that depend on bleaching with a mercuric salt as the first part of the operation. With Monckhoven's intensifier very thin shadow detail becomes reduced, and tones with slightly more strength show no change, while the medium and stronger tones more than double their printing value. In bleaching with mercuric bromide or chloride, exceedingly weak shadow detail is not strengthened, but all other parts of the plate show a uniform increase in intensity.

A negative to be intensified must have been thoroughly fixed, as, otherwise, incurable yellow stains may appear. Thorough washing after fixing is desirable.

The following methods of working will yield negatives of a good black colour, free from any tendency to veiling, staining, or any loss of quality. And, in addition, the results are quite permanent. With all mercurial methods, however, the intensified negative should be varnished, so as to protect the metallic deposit in the gelatine film from atmospheric moisture, otherwise an iridescence will appear, but this may be removed by means of methylated spirit (see "Reducing Negatives by Mechanical Means"). A badly stained negative will not become black by intensification; and, in addition, when a negative depends for its printing quality partly on silver deposit and partly on stain, the result of intensifying will always be uncertain. The intensifier strengthens the silver deposit only, and either decreases the staining or leaves it unchanged.

The chief methods of intensification are:—

Chromium.—The negative is bleached in an acidified solution of a bichromate salt, and then re-developed. The printing value is multiplied by $1\frac{1}{2}$. **Mercuric Chloride.**—The negative is bleached in a solution of mercuric chloride and then blackened with sodium sulphite, ferrous oxalate or by re-development. With sodium sulphite the printing value is only multiplied by $1\frac{1}{2}$; but with ferrous oxalate by 2. **Mercuric Bromide.**—The working is similar to the preceding, substituting bromide for the chloride, and blackening with sodium sulphite or by re-development; the printing value is multiplied by 2. **Mercuric Iodide.**—The negative is strengthened in a solution of mercuric iodide, and then re-developed, the printing value being multiplied by 3. **Silver.**—Various methods of intensifying negatives by means of silver have been introduced. **Lead, Uranium, Copper Bromide, etc.**—These are treated under their own headings.

A method that has been extensively employed is bleaching in a solution of mercuric chloride and then blackening in ammonia. This method is generally considered to be unsatisfactory, and the results not permanent.

Of the above, the mercurial processes are the most used and will here be described. For the others, see separate headings.

Mercurial Processes.—Most of the mercurial methods are satisfactory, the intensified negative being a good neutral black or brown-black, according to the process; there is no staining or veiling; the increase of density is a definite and known quantity, and the result is permanent.

In all processes of mercurial intensification, the mercuric solution should be followed by an acid bath (first suggested by A. Haddon), its object being to prevent the mercury from combining with the gelatine to the detriment of permanency. When the plate is removed from the mercuric solution, it should be washed in two or three changes of water, and then placed in a bath consisting of 1 drm. of hydrochloric acid in 12 oz. of water, remaining in this solution for two or three minutes, being then placed in a second quantity, and finally in a third. Next it is washed for fifteen to twenty minutes, when it is ready for the second part of the treatment.

The following are the details of the principal methods of intensifying with mercury:—

First method—

A. Mercuric chloride	120 grs.	25 g.
Hydrochloric acid	24 mins.	5 ccs.
Water	10 oz.	1,000 "
B. Liquor ammoniæ	$\frac{1}{4}$ oz.	25 ccs.
Water	5 "	500 "

Immerse in A until the image is thoroughly bleached, and then, after treating with acid and washing as above described, immerse in B until thoroughly blackened. Wash, and dry. This method is not recommended.

Second method—

The negative is bleached in solution A (above given), treated with acid, washed, and then thoroughly blackened in—

Sodium sulphite	1 oz.	25 g.
Water	10 "	250 ccs.

This solution must be used at once, as it will not keep. The intensified negative is a good black colour, free from veiling, and the result is permanent; but the increase of density is very slight.

Third method—

H. Chapman Jones advocates this method. The plate is bleached in solution A, and then, after the acid baths and washing, is re-developed with ferrous oxalate. From the developer the negative passes to a weak acid bath for two minutes, and is then washed. This approximately doubles the printing value, and may be repeated as many times as desired, a corresponding increase of strength resulting each time. Care must be taken that the ferrous oxalate developer is freshly prepared and in good condition, or the negative will be badly stained.

Fourth method—

Bleach in solution A, and then, after the acid baths and washing, re-develop with amidol or any clean-working alkaline developer. Pyro is not suitable. The result is similar to that produced by the third method. The image is a good neutral black, there is no tendency to staining or loss of quality, and the result is permanent.

The increase of density is rather less than that given by the third method, but the operation may be repeated with a similar increase of strength.

Fifth method—

Bleach in

C. Mercuric chloride .	120 grs.	27 g.
Potassium bromide	120 "	27 "
Water	10 oz	1,000 ccs.

Treat with three acid baths, wash, and then immerse in a freshly prepared solution of—

D. Sodium sulphite . . .	$\frac{1}{2}$ oz.	55 g.
Water	5 "	500 ccs.

until thoroughly blackened. The resulting negative is a good neutral black without the slightest staining or loss of quality, and it is quite permanent. The printing value is approximately doubled, and repeating the process will not produce any increase of strength.

Sixth method—

The working is as in the fifth method, but the bleached image is blackened in—

E. Sodium sulphite . . .	$\frac{1}{2}$ oz.	55 g.
Sodium carbonate . . .	$\frac{1}{2}$ "	55 "
Water	5 "	500 ccs.

This solution will keep indefinitely. The result is exactly the same as that produced by the fifth method.

Seventh method—

Bleach in solution A, and then, after the acid baths and washing, re-develop in amidol or other clean-working alkaline developer. The gain in printing value is slightly less than that produced by methods 5 and 6, but the strength may be increased by repeating the operation as many times as desired.

Eighth method. Monckhoven's process—

Bleach in solution A, and then, after the usual washing, etc., blacken in

F. Silver nitrate . . .	50 grs.	23 g.
Potass. cyanide (about)	50 "	23 "
Water	5 oz	1,000 ccs.

The silver nitrate is dissolved in the water, and potassium cyanide added, a little at a time, until the precipitate that forms is just dissolved. The plate must be taken from the cyanide solution directly it is blackened through, as a reducing action on the shadow details begins as soon as the blackening is accomplished. If the first washing is not rapid and effective, there will be a similar reduction. It is impossible to prevent a slight reduction in the extreme shadows. The original printing value is rather more than doubled, excepting in the shadows, where the strength is actually reduced. The operation may be repeated if the density is not sufficient, and a proportionate increase of strength will result each time.

Ninth method. Mercuric iodide, Lumière's method—

G. Sodium sulphite . . .	20 grs.	46 g.
Mercuric iodide . . .	1 "	2.3 "
Water	1 oz.	1,000 ccs.

The sodium sulphite must be dissolved first, and then the mercuric iodide, which is insoluble

in water, added; and the solution well shaken until the iodide is dissolved. The solution must be prepared when required, as it will not keep. Immerse the negative in this solution, rocking the dish to ensure even action, and a steady gain in strength will result; the maximum intensity is attained in about seven or eight minutes, but the negative may be withdrawn at any time. Afterwards the plate is washed, immersed in the acid baths as already described, washed, and then re-developed in any alkaline developer. Pyro or any other developer may be used, the printing value not being affected by the choice of developer, but when pyro is used the plate is not quite so clean as with other developers. If the plate is not re-developed, the image will gradually bleach. If the action is carried out fully, repetition will not produce any increase of strength; but if a smaller degree of intensification only is attained at the first operation, repetition at any future time will complete the work and produce the same strength that a full action would have secured in the first instance. The intensity is greater than that given by any other form of mercurial intensification at one operation, the printing value being multiplied by 3.

In all these methods of mercurial intensification, a moderate washing after the final operation of re-developing or blackening completes the work.

In all excepting the ninth method (Lumière's mercuric iodide process), the treatment with the mercuric solution must be thorough and the operation must be taken as far as it will go, the completeness of the work being judged by the thorough whitening of the image. If this bleaching is not thorough, the intensification will be irregular, some portions being fully strengthened and others only partially. It follows, necessarily, that the increase of strength is a fixed quantity; one degree of intensification only can be obtained from any negative, neither more nor less, excepting in those modifications which can be repeated, in which cases the result of repetition is a series of regular steps.

In process work, the negatives have always to be intensified in order to get the necessary intensity for photo-mechanical printing. In wet collodion negatives for line work, the lead intensifier is generally used, followed by ammonium or sodium sulphide for blackening. For half-tone negatives, the copper bromide intensifier is more generally used, both with wet collodion and collodion emulsion, though the lead intensifier can also be employed. With both intensifiers the method known as "cutting" is adopted. This consists in treating the plate with a solution of potassium iodide and iodine, and afterwards applying a solution of potassium cyanide; this cuts off the fringe of the dots or lines, and so sharpens up the image, at the same time clearing the transparent spaces. For dry-plate process negatives the silver cyanide intensifier is found best, and "cutting" is done with potassium ferricyanide and "hypo" solution.

INTENSIFICATION OF PRINTS

Prints by most processes cannot be intensified satisfactorily; and generally intensification is more trouble than obtaining a new print.

Intensification is either impossible or undesirable in the carbon, platinotype, and many silver printing-out methods. Bromide and gaslight prints can be strengthened by bleaching with mercuric bromide and then blackening by means of sodium sulphite, or they may be bleached in mercuric chloride and then blackened by means of ferrous oxalate. Silver intensification has a tendency to stain the paper slightly; and in any method that requires redevelopment care must be taken to use a solution that has no tendency to stain. Another method of strengthening weak bromide and gaslight paper prints is given under the heading "Toning Bromide Prints."

INTENSITY OF LENSES

A term synonymous with angular aperture and focal aperture, and signifying the ratio of aperture to focal length.

INTENSITY RATIO

The ratio of focal length of a lens to the aperture.

INTERFERENCE HELIOCHROMY (See "Lippmann's Process.")

INTERFERENCE IMAGE (See "Lippmann's Process.")

INTERFERENCE OF LIGHT

Light is a wave-like motion in the ether, the waves proceeding in all directions precisely as when a stone is thrown into the centre of a pond. In order to grasp the subject of interference, considerations are here limited to waves proceeding in one direction only, from left to right. The transverse or to-and-fro motion of the ether particles may then be explained as follows: If a series of waves start from contiguous points their individual crests and troughs will coincide, or, in other words, they will be in the same phase, and the result will be that the light is intensified, as the resultant light effect is the sum of the individual wave motions. It is not necessary even for the waves to start from the same point as long as they are in the same phase. If, however, the path of the waves is such that crest falls on trough and trough on crest, then it is obvious that there must be equal forces acting in opposite directions. The result must therefore be no movements, or, in other words, there is an interference of light, and consequently darkness. The waves need not start from the same point; as long as they start from points half a wave-length apart they are in opposite phase.

Hitherto, the path of the light waves has been considered as being in the same direction; but when the direction is changed, as by reflection, then we have standing or stationary waves, which are of considerable interest in that they are the theoretical basis of the Lippmann process.

INTERIORS, PHOTOGRAPHING

In addition to the considerations given under the heading "Architectural Photography," there are a few special points that should be noted. The view of an interior of a room, of a church, or portion of a large building, must necessarily be

taken from within its own limits; therefore a wide-angle lens is necessary. If too wide an angle is included, there is a risk of the perspective effect being exaggerated. About three-fourths of the longer side of the plate, or slightly less, should be the minimum focus employed; and a longer focus is preferable when possible. By care in selecting the point of view the exaggeration of the perspective effect may be minimised.

One of the greatest difficulties in interior work is the presence of windows in front of the camera, especially if they command a clear view of the sky, and form an important part of the lighting of the interior. These windows throw a glare of strong light upon the lens, rendering it practically impossible to secure clear negatives with good gradation and tending to fog the plate. When these windows are not actually included in the picture, a "sky-shade" should be fitted to the camera front; and if this sky-shade is adjustable in position it can be made to exclude all that part of the room where the undesirable windows are situated, without obstructing any part of the subject included on the plate. Another method of accomplishing the same purpose is to have a shield of card or thin wood. In either case, the value of the window in lighting the interior is fully retained.

Where a window commanding a clear sky view is included in the picture it should be covered, whenever practicable, during the greater part of the exposure. There will be no difficulty in doing this when there are other windows which partially light the interior; should it be the only window, it will be quite impracticable to include the whole of it and secure a successful photograph. If part of the window only is included, that part only should be covered, while a shield on the baseboard of the camera prevents the light from the remaining part from reaching the lens. At times, the sun may be streaming through a window that is not included in the picture, but the sunlight may fall on the floor within the field of view and cause an undesirable patch of light or an unequal lighting of the interior. A white blind drawn over such a window, or sheets of white tissue paper attached over that part on which the sun is shining, will form a remedy, these not only diffusing the light but illuminating dark corners in a way that cannot be attained by other means.

In all interiors the inclusion of a liberal proportion of floor or foreground assists in giving a sense of space.

When a wide-angle lens is used in a room which is ten or twelve feet high, or when photographing a small part of a large interior, the camera should be placed much lower than when photographing a large subject with the same lens. A high or normal point of view when including floor very near the camera gives the impression that the ground is running up-hill, this effect being quite obviated by lowering the centre of the lens to about three feet from the ground.

It may be necessary to work with a small stop, as some portions of the subject may be very near the camera, and sufficient depth of focus may not be possible otherwise.

Precautions against the camera tripod slipping must certainly be taken. (See "Tripod.") It

is necessary to acquire the art of capping and uncapping the lens as many times as may be necessary for casual obstructions—persons walking across, etc.—without shaking the camera.

Special points in photographing workshops are treated in the article "Factories, Photographing in." The subject of exposure in interior work is considered in detail under the headings "Exposure" and "Exposure Tables."

INTERMITTENCY ERROR (Fr., *L'erreur intermittente*; Ger., *Intermittierender Fehler*)

The failure of a series of intermittent exposures to produce the same effect as an equivalent continuous exposure. This is of considerable importance in sensitometric work, where a sector wheel or other device is used for testing plates.

INVERSION, LATERAL (Fr., *Inversion latérale*; Ger., *Seiten-Umkehrung*)

The reversal of right and left, as seen when objects are viewed in a mirror. A ferrotype photograph, taken direct on a metal plate, is laterally inverted, as was also the daguerreotype. Lateral inversion becomes serious in photographs of buildings, or where lettering occurs. A negative on a modern dry plate is laterally inverted, but the inversion is corrected in printing. In the carbon process (*which see*), special precautions are taken to avoid lateral inversion, either double transfer or a reversed negative being resorted to. Reversed negatives are also used in photo-mechanical processes, since if blocks or plates showed the picture the right way round it would obviously be inverted in the printed impressions. Strictly speaking, what is called a reversed negative is really unreversed; it is the ordinary negative which properly deserves the name. It is the custom, however, to apply the term to negatives that give reversed prints. (*See also* "Reversed Negative.")

INVISIBLE IMAGE (*See* "Latent Image.")

INVISIBLE RAYS, PHOTOGRAPHING BY

The fact that photography can depict objects invisible to the eye has long been known. Fox Talbot referred to the subject in his book, "The Pencil of Nature," published in 1844, and his own words are: "Among the many novel ideas which the discovery of photography has suggested is the following rather curious experiment or speculations. When a ray of solar light is refracted by a prism and thrown upon a screen, it forms there a very beautiful coloured band known by the name of the solar spectrum. Experimenters have found that if this spectrum is thrown upon a sheet of sensitive paper, the violet end of it produces the principal effect, and, what is truly remarkable, a similar effect is produced by certain invisible rays which lie beyond the violet, and beyond the limits of the spectrum, and whose existence is only revealed to us by this action which they exert. Now I would propose to separate these invisible rays from the rest by suffering them to pass through into an adjoining apartment, through an aperture in a wall or screen. This apartment would thus become filled (we must not call it illuminated) with invisible rays, which might be scattered in

all directions by a convex lens placed behind the aperture. If there were a number of persons in the room, no one would see the other; and yet nevertheless if a camera were so placed as to point in the direction in which anyone was standing it would take his portrait." More than half a century later Edgar Senior, of the Battersea Polytechnic, took a most successful portrait under what are practically those conditions. The source of dark (invisible) rays was an arc lamp, the visible light being cut off at the lens by means of special screens invented by Prof. R. W. Wood; the necessary exposure was five minutes. The "X-rays" discovered by Prof. Röntgen, of Würzburg, in 1896 are invisible rays, and the work they will do is common knowledge. (For "X-ray" work, *see* under its own heading.)

The photographic spectrum therefore stretches out beyond both ends of the visible spectrum, and measures seven or eight times the length of the visible spectrum. Thus, not only do ultra-violet rays give results photographically, but the infra-red as well, although the latter are, of course, at the opposite end of the spectrum and below the visible red.

Prof. Sylvanus Thompson, at the Royal Institution in 1896, illuminated a piece of apparently white paper by means of a powerful arc-lamp. A photograph was then taken of the white paper, and the negative showed an inscription written thereon. This inscription had been written upon the paper with an acid (citric or sulphuric) solution of sulphate of quinine, which, being like water in appearance, could not be seen by the eye. The camera detected it, however, because the chemical liquid absorbed the ultra-violet rays, and they were not reflected to the plate, hence they appeared black. The experiment may be made by anyone, but it is important that a wet collodion plate be used and not a modern dry plate. Dr. Gladstone made similar experiments as early as 1873, and exhibited his results at the Bradford meeting of the British Association in that year.

There are many substances that are fluorescent, or that change the refrangibility of rays of light, and which have a light action upon a photographic plate. An unlighted incandescent gas-mantle gives off sufficient invisible rays to make an image upon a photographic plate. Among other substances are radium, mineral uranite, certain salts of uranium, canary glass, alcoholic solution of chlorophyll, æsculin, tincture of stramonium seeds, and of turmeric.

Prof. Wood, of the Johns Hopkins University (U.S.A.), has paid particular attention to the action of the invisible ultra-violet and infra-red rays, and his lecture before the Royal Photographic Society on September 27, 1910, should be referred to for full particulars.

IODIDE (Fr., *Iodure*; Ger., *Iodid*)

A combination of iodine with a metal. All the iodides—with the exception of a few of the heavy metals, lead, silver, mercury, etc.—are soluble in water, and generally of bright colours. They are formed by treating the metal in powder with iodine direct. The alkaline iodides are prepared in the same way, or by acting on iron iodide by an alkaline carbonate. The following

table gives the equivalent quantity of the principal iodides used in photography and their corresponding proportion of iodine :—

Iodine	Ammonium iodide	Potassium iodide	Sodium iodide	Cadmium iodide	Zinc iodide
1.000	1.142	1.307	1.181	1.441	1.255
0.876	1.000	1.145	1.262	1.262	1.099
0.765	0.874	1.000	1.102	1.102	0.960
0.847	0.967	1.107	1.220	1.220	0.630
0.694	0.793	0.907	1.000	1.000	0.871
0.797	0.910	1.042	1.148	1.148	1.000

In process work, an iodide solution is used in the intensifying and "cutting" of line and half-tone negatives, as described under the heading of "Intensification of Negatives."

IODINE (Fr., *Iode*; Ger., *Iod*)

I. Molecular weight, 127. Solubilities, 1 in 5,000 water, 1 in 12 alcohol, 1 in 3 ether; soluble in carbon disulphide and solutions of alkaline iodides. It occurs as glistening steel-blue-black plates with peculiar odour; and it is obtained from seaweeds. It is poisonous, the antidotes being emetics, the use of the stomach pump, magnesia, starch solution, and "hypo." A solution of iodine in an aqueous solution of potassium iodide is used for bleaching bromide prints for sulphide toning, the formula being :—

Potassium iodide	. 200 grs.	20 g.
Distilled water	. 1 oz.	50 ccs.

Dissolve and add—

Iodine	. . . 10 grs.	1 g.
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and when thoroughly dissolved add—

Distilled water to	20 oz.	1,000 ccs.
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Immerse the print in this till the image is bleached. The paper becomes stained dark blue, which may be discharged by a 10 per cent. solution of sodium sulphite.

Small quantities of iodine are added to collodion to ripen it, and a few drops of a 1 per cent. alcoholic solution is recommended as an accelerator with hydroquinone.

In process work, iodine has important uses. When collodion becomes colourless or lighter in colour it is apt to give foggy plates. In this case add 1 min. of solution of iodine in alcohol (2 grs. in 1 drm.) to each ounce of collodion.

IODISER (Fr., *Iodo-bromure*; Ger., *Iodirungsflüssigkeit*)

A solution of metallic or alkaline iodides and bromides in alcohol, kept as a separate stock solution and added to collodion just before use. (See "Collodion Process (Wet).")

IDO-BROMIDE (Fr., *Iodo-bromure*; Ger., *Bromidid*)

Applied to emulsions containing bromide of silver plus a small proportion of iodide.

ODOEOSIN (See "Erythrosine.")

IDOSE

In order to simplify the operation of iodising collodion, a compound called iodose has been

introduced. A dry mixture of suitable iodising salts is made in the proper proportions, so that the compound has only to be dissolved in alcohol and added to the collodion.

IRIDESCENCE (Fr., *Iridescence*; Ger., *Scheinfärbung*)

The play of colours seen in thin films, such as oil on water, in the opal, mother-of-pearl, etc., and due to the interference of light in extremely thin films. Iridescent colours are occasionally seen between the cemented combinations of lenses, and are then due to partial separation; the remedy is to separate and re-cement them, which is work that is best done by an optician.

IRIDESCENT HELIOCHROMY (See "Lippmann's Process.")

IRIDESCENT MARKINGS

Chemical fog often seen in the form of green stains at or near the edges of plates and films; known also as green or dichroic fog. It may be due to stale plates, stale sodium sulphite, and forcing under-exposed plates with the pyrammonia developer. It rarely occurs when soda or potash is used as an alkali, or with any of the newer developers. It may be cured by bleaching the plate, after well washing, in :—

Ferric chloride	. . 20 grs.	23 g.
Potassium bromide	. 40 "	46 "
Water	. . . 2 oz.	1,000 ccs.

The plate will be reduced slightly in density as the iridescent fog disappears. It is afterwards well washed and re-developed, in daylight, with hydroquinone, metol, or ferrous-oxalate (the last-mentioned preferred), until of the desired density, it being finally re-fixed and washed.

In process work, the degree of contact obtained in the screw-pressure frames between the process negatives and the metal plates is judged according to the iridescent markings visible through the thick front glass of the frame. These markings are due to the phenomenon known as Newton's rings.

IRIDIUM CHLORIDE OR TETRACHLORIDE, IRIDIUM AND POTASSIUM CHLORIDE, AND IRIDIUM AND SODIUM CHLORIDE

IrCl_3 ; IrCl_2KCl ; and $\text{IrCl}_2\text{NaCl}_2$ or Na_2IrCl_6 , respectively. These are respectively dark brown, red, and brownish-black crystals which have been suggested for toning prints, and are occasionally used in ceramic work. Practically, however, they are of but very slight photographic interest.

IRIDIUM AND GOLD TONING BATH (See "Gold and Iridium Bath.")

IRIS DIAPHRAGM (See "Diaphragm.")

IRIS VIGNETTER (See "Vignetter.")

IRON PRINTING PROCESSES

Processes of printing by means of salts of iron are described under the heading "Ferric Salts, Printing with."

IRRADIATION (Fr., *Irradiation*; Ger., *Strahlenwerfen*)

A theory that has been propounded in regard to the formation of the dots in half-tone process negatives, especially in collodion emulsion and dry plates, accounts for the want of sharpness by irradiation of light from particle to particle of the silver forming the image.

ISINGLASS (Fr., *Ichthyocolle*; Ger., *Hausenblase Fischleim*)

A gelatine obtained from the swimming bladder of various species of fish. It occurs in thin plates or fine white shreds with a yellowish tinge. It is entirely soluble in boiling water, and sets to a jelly on cooling. It is occasionally used as a substratum and in mountants.

In process work, isinglass has been used instead of, or as an addition to, gelatine, especially in some old methods of collotype and photolithography. Also it has been suggested as a substitute for fish-glue in the enamel process, but it has no advantages.

ISOCHROMATIC PHOTOGRAPHY

Photography in which colours are rendered in a monochrome picture according to their true visual brightness. Known also as orthochromatic photography. It is well known that yellow or red objects appear very dark in an ordinary photograph. The ordinary plate is chiefly affected by violet and blue rays of light, and is comparatively insensitive to green, yellow, orange, and red rays. Hence, blue objects impress the plate far too strongly, comparatively, the result being that they appear much too light in the photographic print. This serious fault is very evident in photographs of vividly coloured objects, and isochromatic methods are adopted to overcome it. The plates used (see "Isochromatic Plates") have been treated in a way that renders them "colour sensitive," but as plates made sensitive to green, yellow, and orange-red rays are still too sensitive to blue-violet, a compensating screen is placed in front of the lens, so that the blue-violet rays are lessened in intensity. A further function of the screen is that it entirely absorbs the ultra-violet rays, which otherwise affect the plate; and as they are invisible, it is of course necessary that they play no part in the formation of the photographic image.

Vogel and others discovered that by mixing certain aniline dyes with the silver bromide emulsion of a plate, the latter becomes sensitive to the colours absorbed by the dye (or the dyed silver bromide particles). It is hence possible to adapt a dyed or "isochromatic" plate and a screen so that the combination will result in objects of all colours being represented in the print in tones of visual brightness corresponding. Yellow-green being the brightest colour visually, objects of this colour will appear lightest in the print, and so on. Isochromatic photography as usually practised is more particularly a rough compromise, as to give accurate colour records too long exposures would be necessary, owing to the slowing effect of the yellow screen. (See also under the headings "Isochromatic Plates," "Isochromatic Screens," and "Monochrome, Rendering Colours in.")

ISOCHROMATIC PLATES

Plates specially sensitised for colour, and used with compensating light filters or isochromatic screens. They may be roughly grouped into three classes: (1) those which are sensitised for green and yellow rays of light, and give an approximately true colour rendering; (2) those which are sensitised for the entire spectrum, often called "panchromatic" (*which see*); and (3) plates rendered sensitive to orange and red, but which lack green sensitiveness.

There are a great many varieties of the first type, but all possess what is termed a maximum of colour sensitiveness in the yellow-green region; staining an ordinary plate with certain of the aniline dyes induces this sensitiveness, and erythrosine is characteristic of type 1 in its action. Panchromatic plates being discussed under their own heading, this article will deal only with the first and third types. The ordinary isochromatic or orthochromatic plate has a distinct maximum in every instance in the green-yellow region of the spectrum, and its sensitiveness generally ends off abruptly at about the D line ($\approx \lambda 5893$). Such a plate can be prepared by bathing, this process giving excellent results provided that the plates bathed are used a day or two after being treated. Two solutions should be made up as follow:—

A. Erythrosine	10 grs.	1 g.
Alcohol	4 oz.	166 ccs.
B. Liquor ammoniæ (·880) 1 drm.		5·2 "
Water	24 oz.	1,000 "

For use, 1 drm. of A is mixed with 6 oz. of B a few minutes before use. Great care must be taken only to bathe clean working dry plates of medium rapidity, about 150 or 180 H. and D. (pyro-soda or pyro-metol speed). A "safe" ruby light must be employed for the illumination of the dark-room. (See "Colour Screen or Filter.") Scrupulous cleanliness must be observed, dishes etc., being thoroughly clean in the strict chemical sense. The quicker the bathed plates are dried, also, the better, so that a warm room in which they will become dry in two to three hours should be chosen if possible. The plates are placed in the dish, and flooded over with the solution, 2 oz. being allowed to each half-plate; the dish is gently rocked for three minutes, and the plates are then placed in another dish and given six rinses in plain water or left under a running tap for two minutes. They should be placed in a new wooden rack to dry, and this rack should not be used for any other purpose. Dry in complete darkness.

A sensitiser for the green and blue-green rays, which tends to slow the plates, may be prepared thus:—

Auracin	1 gr.	·23 g.
Boiling water	10 oz.	1,000 ccs.

Allow to cool, then filter the solution, and add $\frac{1}{2}$ drm. of strong ammonia.

Plates of type 3 are difficult to prepare because, owing to their great red sensitiveness, the work must be done almost in darkness. A suitable solution for bathing may be made up as follows:—

Cyanine blue (ethyl cyanine or pinacyanol)	1 gr.	·23 g.
Alcohol	8 oz.	1,000 ccs.

Add $\frac{1}{2}$ oz. of this to 6 oz. of distilled water, add $\frac{1}{2}$ drm. of strong ammonia, allow to stand for twenty minutes, and filter. Two ounces of solution will suffice as before for one half-plate.

There has been a tendency of late to produce plates so highly sensitive to greenish-yellow that when used without a screen quite satisfactory colour renderings can be obtained. Such plates are by no means perfect, but they show a marked improvement over ordinary plates. A "no-filter" plate may be prepared by means of the following solution:—

A. Erythrosine	1 gr.	23 g.
Distilled water	1 oz.	100 ccs.
B. Liquor ammoniæ (.880)	$\frac{1}{2}$ "	55 g.
Distilled water to	10 "	1,000 ccs.
C. Silver nitrate	2 gr.	46 g.
Distilled water	1 oz.	100 ccs.

Mix equal parts of A, B, and C, and dilute the mixture with an equal volume of distilled water. Select slow ordinary plates, bathe them for two minutes each, rinse them well under the tap, and put them in the rack to dry. Very intense green-yellow sensitiveness is thereby produced, but no such plate will give an accurate colour rendering, because it is still sensitive to ultra-violet rays, to extinguish which a yellow filter is necessary.

Isochromatic plates of commerce are made by adding carefully selected and purified dyes, dissolved in alcohol or water, to the liquid emulsion with which plates are coated. The sensitive particles of emulsion are thereby coloured, though often almost imperceptibly, and their colour absorption altered in consequence, so that rays of light for which the plates are "sensitised" are absorbed. One of the earliest descriptions of an isochromatic emulsion for plates was given in Tailfer and Clayton's patent specifications of 1882-3.

ISOCHROMATIC SCREENS

Only those rays of light that are visible to the eye should be allowed to affect the photographic plate; besides the visible rays of the spectrum, there are two sorts of invisible ones—the ultra-violet and infra-red—situated respectively before the violet and after the red rays. The ultra-violet rays are particularly active photochemically, and are present in daylight and all the kinds of artificial light usually employed for photographic work. It is the primary function of the isochromatic (or orthochromatic) screen to absorb these rays, and the ordinary screen is therefore a yellow glass of the requisite shade, which is placed in front of or behind the lens, or immediately in front of the plate, or it is sometimes fixed in the lens diaphragm between the two components of a doublet or other compound lens. The next function of the screen is to cause rays of each colour to act upon the plate to an extent dependent on their visual brightness. Thus a yellow daffodil photographed against a dark blue background should appear as a light grey flower against dark grey; with an ordinary plate the daffodil would appear darker than the background. The isochromatic screen is yellow, and therefore "damps down" the action of the blue rays by partially absorbing

them, so that in the negative the blue background would come out faint and would therefore appear dark, as it should be, in the print.

No plate, however carefully colour-sensitised, is sensitive to all colours in degrees proportionate to their visual luminosity. The erythrosine type of plate, for example, is always deficient in the bluish-green region. The screen must compensate for such deficiencies by absorbing those colours to which the plate is most sensitive, to such an extent that the other colours are adequately recorded. The average "isochromatic" plate is not red-sensitive, and only an approximately correct colour rendering can therefore be obtained, unless a panchromatic plate and a properly adapted light filter are employed.

For general working, a very fair "orthochromatic" effect is obtained by using a yellow-green sensitive plate, and a yellow screen which cuts out all ultra-violet rays and depresses the blue-violet, though it is, of course, better to use one special type of colour-sensitive plate and a screen adapted accurately to it. The yellow screen is more usually made by dyeing the film of a piece of optically flat glass which has been coated with pure neutral gelatine. The dye should give as transparent a filter as possible; that is, the screen should be pale, and exposure only increased by a minimum amount. Thus, while naphthol yellow and tartrazine are good dyes for the purpose, a screen can be made with filter yellow K, or rapid filter yellow, which gives equally good results, while exposure is only increased perhaps half as much as it is in the former case.

Gelatine-coated glass may be stained with a 1 : 500 solution of the yellow dye selected, and filters of various intensities should be made; the best one to use may be found by experimental exposures on an actual coloured subject.

To adapt a light filter or screen correctly to a given plate, two methods are available. One is to test the experimental screens by photographing the spectrum through them, and varying the colour until each portion of the spectrum is recorded in the negative with a density proportionate to its visual intensity; the other is to photograph a test chart, which is most conveniently made by drawing concentric circles on a card and dividing each of these circles into two parts, one painted black, the other coloured; blue, green, and orange are the best colours to use if a panchromatic plate is being tested, or blue-violet, blue-green, and gamboge if a green-yellow sensitive plate. The circular card is attached to a small motor and revolved rapidly, and the amount of black in each ring is increased until all the rings appear of equal luminosity. If a correctly compensating screen be used, then each ring will appear, in a photograph taken of the disc, of equal density. The screen must be experimented with until this result is obtained.

A liquid filter is very convenient for experimental work, as its colour may be varied at will by adding concentrated dye solutions. Thus by adding, say, *m* ccs. of a 1 : 100 solution of filter yellow and *n* ccs. of a 1 : 100 solution of crocein scarlet to water contained in a flat glass cell of 16 sq. cm. area, a liquid screen is obtained which satisfies the tests for a good colour rendering. Flat glass can then be coated with a 5 per cent. solution of gelatine, allowing,

for example, 1 cc. to coat each 10 sq. cm. of surface; each cc. of the gelatine solution must therefore contain $\frac{10}{100} \times \frac{m}{100}$ or $\frac{m}{160}$ g.

of the yellow dye, and $\frac{n}{160}$ of the orange dye, and so on. Stained gelatine filters are usually bound up with a cover glass, the two glasses being cemented together with Canada balsam.

Pot glass filters (made from glass coloured in the mass in course of manufacture) are usually inefficient, requiring prolonged exposures owing to a considerable percentage of grey in the glass.

The multiplying factor is important in isochromatic photography, as by under- or over-exposure and attempted correction in development, the colour contrasts in monochrome may be somewhat falsified. All yellow screens necessitate an increase in exposure of from two to ten or fifteen times the normal. A screen with which five times the normal exposure is required is often designated a $\times 5$ screen, and so on. The only satisfactory way to find the multiplying factor is to photograph a black-and-white object, giving varying times of exposure, and judging from the results which is the correct one. This should be verified then on a landscape.

ISOCYANINES (Fr. and Gr., *Isocyanine*)

A class of dyes for colour-sensitising plates, all complex derivatives of cyanine, which they have superseded. The group includes orthochrome T (introduced in 1903), pinachrome (1904), pinaverdol, pinacyanol, homocol, and dicyanine. These are treated under their respective headings. Pinacyanol is the best sensitiser for the extreme visible red, while dicyanine sensitises for the infra-red.

ISOTYPE

A process of half-tone negative making proposed by Vittorio Turati, and expounded in an elaborate treatise. The system depends on the use of variously shaped diaphragms in conjunction with a suitable screen distance. The latter is determined by means of what the inventor termed a "finder" stop, having two small openings placed at a mathematically determined distance apart. The image of this stop is viewed by means of a microscope through the ruled screen, whilst the latter is moved to and fro until a position is found where the images of the two openings coincide in the focal plane. The variously shaped diaphragms can be put in the lens, and different patterns of dot formation are obtained on the negative, although the ordinary cross-ruled screen has been used throughout. The process has not come into commercial use.

"IT"

Sir William Abney in his presidential address before the Royal Photographic Society, in October, 1896, proposed the term "It" (the initials of intensity and time) as an expression of the unit of exposure. He used the term provisionally only, and suggested that a unit might be called "talbot," just as in other branches of physics the units were named after pioneers, as, for example, the "watt," the "volt," and the "ampère."

IVES' COLOUR PROCESSES

F. E. Ives, of Philadelphia, U.S.A., may be considered as one of the pioneer workers in practical three-colour work, as it was mainly by his efforts that the true theory of the processes was recognised and of recent years reduced to practical results. He laid down the principle, though it had already been enunciated by Clerk-Maxwell and Ducos du Hauron, that the object to be reproduced in colours should be photographed through three separate screens or colour filters, which should give negatives that represented by light and shade the degree to which light coming from different portions of the subject excites a single primary colour sensation in the eye; and that for projection these three photographs should be projected simultaneously upon a screen, each by light which excites only the primary colour sensation which it represents, and in such manner that the three-coloured images are superimposed. This involves the production of one photograph by the joint action of the red, orange, yellow, and yellow-green rays, but chiefly by the orange, so as to represent the effect upon the red sensation; another by the joint action of the orange, yellow, yellow-green, green-blue rays, but chiefly by the greenish yellow rays so as to represent the action of the green sensation; and a third photograph by the joint action of the blue-green, blue, and violet rays, but chiefly by the blue rays to represent the action of the blue sensation. Positives from negatives were projected, the first by pure red light, the second by pure green light, and the third by blue-violet light. Several cameras of varying types have been devised by Ives to obtain the negatives, some in which the image formed by one lens was split up by means of mirrors into three images, and others with three lenses. In his latest type only one lens is used, and a reflector splits the image up into two parts, and one image is received by one plate, and the other two by a plate and a celluloid film placed surface to surface with a colour screen in between.

IVES' HALF-TONE PROCESS

One of the early half-tone processes. It was invented by F. E. Ives, and patented in America in 1878. A gelatine relief was cast in pure white alabaster plaster, and brought into contact with an indiarubber sheet covered with pyramidal raised points or lines which had been inked. According to the amount of relief on the cast the rubber points were more or less spread out, and thus gave dots of ink of varying size on the surface of the cast. The light and shade of the image was thus reproduced, and the cast was then photographed, the negative being equivalent to the half-tone negative now secured through the ruled screen.

IVOIRE DUR

The name by which carbon pictures upon porcelain were once known, owing to their being an imitation of photographic prints upon ivory.

IVORY (Fr., *Ivoire*; Ger., *Elfenbein*)

The tusks of the elephant; a very hard white or creamy white bone-like substance which is occasionally used as a support for prints.

IVORY, ARTIFICIAL

Artificial ivory is either white vulcanite or white opaque celluloid.

IVORY BLACK (Fr., *Noir d'ivoire*; Ger., *Elfenbeinschwarz*)

Calcined ivory scrap, turnings, and powder, used as a pigment.

IVORY, PHOTOGRAPHS ON

Generally, photographs are printed on ivory by the carbon transfer process (*which see*). Other methods have been advocated, as, for example, sensitising the ivory and printing by contact or through a camera, but the carbon process is the easiest and best. Such pictures are largely used for the production of coloured miniatures, the print being made weak to serve as a base for the colours.

IVORYTYPE

An imitation of prints upon ivory. The working directions are as follow: Select a print upon plain salted paper, strong and brilliant; prints from flat negatives do not give pleasing effects. Edge a glass plate with mountant to the extent of about $\frac{1}{4}$ in.; damp the picture, and lay it face upwards upon the glass so that it

becomes fastened by the edges. The glass should be of such a size as to leave about $\frac{1}{4}$ in. margin round the print. When dry, the print will be found stretched tight upon the glass. It is then coloured with bright water-colours or aniline dyes. A flat slab of soap-stone is now taken, the glass bearing the print is mounted upon it, and the whole placed over a gas-stove or oil-stove until the glass is hot enough to melt wax. A cake of white (not paraffin) wax is then rubbed over the warm surface of the picture. The wax gradually melts and saturates the print, which at this stage presents a hopeless appearance, and appears to be ruined. The print is next cut round the edges, so as to detach it from the glass. A sheet of clean plate glass is heated in the same manner as the first piece, and the print, waxed face down, is laid upon it. The wax soon causes glass and paper to adhere, and any air-bubbles can be pressed out by using a piece of wax with a straightedge as a squeegee. The glass with the print upon it is then allowed to cool, and the print is next backed up with white cardboard, and bound at the edges with binding strips, or the card is attached by means of wax. Finally, the whole is framed.

Prints produced by the "Eburneum Process" (*which see*) have also been called ivorytypes.

J**JAFFÉ'S PAPER**

A commercial photo-lithographic transfer paper, sized with hardened gelatine, which has to be sensitised in a bath of potassium bichromate. Max Jaffé recommends the addition of manganese oxysulphate to the bath in summer time. Two kinds of this paper are made, one having the natural gelatine surface and the other being highly glazed. The latter is recommended for half-tone and delicate line work.

JAFFÉTYPE

A half-tone process, invented by Max Jaffé, of Vienna, consisting of printing from an ordinary continuous tone negative on to a collotype-prepared plate, with a piece of gauze interposed. Thus a kind of half-tone print was obtained from which lithographic transfers were pulled and put down on metal for etching into relief.

JAUNE BRILLANT

A pigment consisting of a mixture of cadmium yellow, vermilion, and white-lead, and used occasionally for colouring photographs.

JAVELLE WATER (*See* "Eau de Javelle.")**JENA GLASS** (*See* "Glass.")**JEWS' PITCH** (*See* "Asphaltum.")**JOLY'S COLOUR PROCESS**

A screen-plate process of colour photography, introduced in 1894, in which a glass plate ruled with parallel lines, about 150 to the inch, of red, green, and blue-violet, was placed in front of a panchromatic plate during exposure, and gave an image in lines corresponding to the distribution of the colours of the object. From this a transparency was made in the ordinary way and bound in contact with a viewing screen ruled with lines of similar width and adjusted till the object was seen in its natural colours. (*See* "Screen-plate Processes.")

JOSEPH, PAPIER

An extremely soft Japanese tissue paper of silky texture, used for cleaning glass.

JOUGLA PROCESS (*See* "Omnicolore Plate.")**JUNIPER RESIN** (*See* "Gum Sandarac" under the heading "Gums and Resins.")

K

K SCREENS

A commercial name for yellow screens prepared with filter yellow K.

KACHIN (Fr. and Ger., *Kachin*)

A developer, possibly identical with and certainly resembling pyrocatechin. It is soluble in water (28 in 100); keeps well; does not stain fingers, plates, or papers; and gives good black images. The standard formulæ are:—

One-solution Developer

Sodium sulphite	. ½ oz.	27.5 g.
Sodium carbonate	. 1 "	55 "
Kachin	. 100 grs.	11.5 "
Water	. 20 oz.	1,000 ccs.

The above is ready for use.

Two-solution Developer

A. Kachin	. 160 grs.	18 g.
Sodium sulphite	. 2½ oz.	137.5 "
Water	. 20 "	1,000 ccs.
B. Sodium carbonate	. 2 oz.	110 g.
Water	. 20 "	1,000 ccs.

Use equal parts of A and B. Dilute with water for softer results. Use as a restrainer 10 to 30 drops of a 5 per cent. solution of borax to each ounce of developer.

Another popular form of a two-solution developer of a different character is:—

Two-solution Developer

A. Kachin	. 192 grs.	22 g.
Sodium sulphite	. 2 oz.	110 "
Water	. 20 "	1,000 ccs.
B. Sodium phosphate	. 3½ oz.	200 g.
Caustic soda	. 192 grs.	22 "
Water	. 20 oz.	1,000 ccs.

For use, mix 1 part of A, 1 part of B, and 1 part of water. A few drops of a 10 per cent. solution of potassium bromide per ounce of developer has very great restraining power, and is of use in cases of extreme over-exposure. A curious and valuable property of kachin is that it gives better results on very stale plates than any other developer. Kachin has been advocated for use in developing and fixing a negative in one operation. (For formulæ see "Developing and Fixing Combined.")

KALEIDOSCPIC PHOTOGRAPHY

Photography of the multiple images produced by two mirrors placed at an angle with one another, as in the kaleidoscope. The symmetrical images given by the latter instrument are often photographed for the use of designers. (See also "Polyscope.")

KALLITYPE

A printing process invented by Dr. W. J. Nichol in 1899. Paper, coated with a mixture

of a ferric salt and silver nitrate, gives, on exposure to light behind a negative, an image in ferrous oxalate and silver oxide which, on the application of a suitable developer, precipitates an image in metallic silver. The principle of the process is old, and was foreshadowed by Herschel's obsolete "Chrysotype" process. The instructions immediately following are practically those originally published by Nichol, who at one time placed the paper ready for use on the market but withdrew it because he was not satisfied with the permanency of the results; his fixer was a weak solution of ammonia, but later experiments proved that the use of "hypo" as a fixer gave more permanent prints.

The paper, preferably after sizing, is sensitised by coating with:—

Ferric oxalate	. 750 grs.	167.5 g.
Silver nitrate	. 300 "	67 "
Oxalic acid	. q.s.	q.s.
Distilled water	. 10 oz.	1,000 ccs.

Place the ferric oxalate in a bottle with the water, which stand in a saucepan of water, and gradually heat until the ferric oxalate dissolves. If there is need, add not more than from 5 to 10 grains of powdered oxalic acid to assist solution. Filter the hot solution, and add the silver nitrate to the clear filtrate; this will keep good in the dark for several months. The paper is then coated (in a yellow light) after the manner described under the heading "Blue-print Process," dried, and printed upon until of a bluish brown colour upon a yellow ground. At this stage the image consists of reduced iron (ferrous) salt which has the power of reducing the silver nitrate to a metallic state, which power, however, is latent until a developer (a solvent of the ferrous salt) is applied to the paper.

Of the many possible developers, the chief are sodium tungstate, Rochelle salt, sodium acetate, and borax.

(1) For Black Tones—

Borax	. 1 oz.	110 g.
Rochelle salt	. ¾ "	82.5 "
Potassium bichromate		
(1 % solution)	. 7-9 drms.	87-112 ccs.
Water	. 10 oz.	1,000 "

(2) For Sepia Tones—

Rochelle salt	. ½ oz.	55 g.
Potassium bichromate		
(1 % solution)	. 4-5 drms.	50-62 ccs.
Water	. 10 oz.	1,000 "

(3) For Purple Tones—

Borax	. ½ oz.	27.5 g.
Rochelle salt	. 1 "	110 "
Potassium bichromate		
(1 % solution)	. 7-9 drms.	87-112 ccs.
Water	. 10 oz.	1,000 "

(4) For Maroon Tones—

Rochelle salt . . .	1 oz.	110 g.
Sodium tungstate . .	$\frac{1}{2}$ "	55 "
Water	10 "	1,000 ccs.

The print is immersed in the developer and the dish is rocked for from fifteen to thirty minutes. Although the image may appear quickly, the print must remain in the bath some time in order to render the iron salts completely soluble. The print is then passed direct, without washing, into the fixing bath, consisting of—

Sodium hyposulphite . .	1 oz.	55 g.
Liquor ammoniac (880) .	$\frac{1}{4}$ "	12.5 ccs.
Water	20 "	1,000 "

The print is kept on the move in this bath for about ten minutes, then washed for about twenty minutes, and finally dried. Some workers advocate a second immersion in a fresh fixing bath (as above) in order to be sure of thorough fixing, which is absolutely necessary to secure permanent pictures.

A finished kallitype picture has an image consisting of metallic silver, and it may therefore be toned with gold, platinum, or by the sulphide process, if desired.

Modified Kallitype.—Another and more modern paper is that known as "Water-developing kallitype," which is a good paper for home production, but the warm brown results cannot, as a rule, be said to equal those given by the proper kallitype process described above. Four solutions are necessary for sensitising:—

A. Green ferric ammonio-citrate . . .	1,100 grs.	252 g.
Water	10 oz.	1,000 ccs.
B. Tartaric acid . . .	180 grs.	41 g.
Water	10 oz.	1,000 ccs.
C. Silver nitrate . . .	460 grs.	106 g.
Water	10 oz.	1,000 ccs.
D. Gelatine	300 grs.	69 g.
Water	10 oz.	1,000 ccs.

The A and C solutions keep well in the dark; the B solution keeps for a few days only, owing to the formation of mould; while the D solution should be made just before use, the gelatine being soaked in the water and dissolved by heat. Equal parts of the four solutions added together form the sensitiser; A and B solutions should be added to the warm gelatine D, the whole being kept warm by placing the measure, say a 10 oz. graduate, in hot water. The C solution is then added very slowly, stirring the combined mixture with a glass rod the while. The warm solution is then coated upon the plain paper, and as soon as the coating has lost its wet appearance and begins to look dull the paper is hung up in a warm room and out of the way of actinic light to dry; when dry it is ready for printing.

The print needs to be vigorous; from the printing frame it passes into plain water for about two minutes, and in this the image develops up to a greater strength and of a reddish brown colour. It is then transferred to a weak "hypo" fixing bath ("hypo" 50 grs., water 5 oz.) or to a 10 per cent. sodium sulphite solution, in which the print becomes a richer brown in colour. Finally, the print is washed for about half an hour, and dried.

American Kallitype.—In America much attention has been paid to kallitype, and many formulæ and improvements have been introduced. The Jas. Thomson process needs a "salting" and a "sensitising" solution:—

Salting Solution

Ferric-ammonio citrate . . .	200 grs.	45 g.
Ferric oxalate	120 "	27 "
Potassium oxalate . .	120 "	27 "
Copper chloride . . .	60 "	13.5 "
Oxalic acid	40 "	9 "
Gum arabic	100 "	22.5 "
Distilled water . . .	10 oz.	1,000 ccs.

The paper (sized if velvety tones are desired) is coated with the above, dried, and treated with the sensitiser:—

Oxalic acid	20 grs.	4.5 g.
Citric acid	200 "	45 "
Silver nitrate	500 "	112.5 "
Water	10 oz.	1,000 ccs.

When surface dry, complete the drying by gentle heat, but excess of heat will convert the ferric salt to ferrous. For printing, three or four minutes in sunlight is generally sufficient. The image appearing is chestnut brown upon a yellow ground, and printing should be stopped before the half-tones appear. The print is placed direct into clear cold water, where it will develop fully; four changes of water, or about three minutes in running water, will be sufficient. After washing, fix in a weak "hypo" bath (50 grs. to 32 oz.); a ten-minute immersion is generally sufficient. Wash in plain water for about half an hour and dry; the resultant colour should be a good brown.

Single-solution Kallitype Sensitiser.—The following sensitiser is one of the simplest and most widely used for menu, note paper and post-card work. Geo. E. Brown, who has advocated it, gives the following directions: 55 grs. of silver nitrate is dissolved in 4 or 5 drms. of distilled water; and liquor ammoniac (880), diluted with an equal quantity of water, is very carefully added. As the first drop or two is added, a copious precipitate of silver oxide is thrown down in the solution. Addition of more ammonia solution will re-dissolve this precipitate; cease to add ammonia on the disappearance of the last traces of the precipitate. Weak sulphuric acid is next added drop by drop until the faint odour of ammonia disappears. 40 grs. of green ferric ammonium citrate dissolved in 6 drms. of water is then added, and the liquid is complete. Stored in the dark or in a stone bottle, it will keep good for several months. It is applied to paper in the same way as other kallitype sensitisers, dried, and the paper treated as before described, namely, with water and "hypo."

After-treatment.—Kallitype prints may be toned, reduced, re-developed, and intensified. For toning, a simple combined bath which works well is: Water, 8 oz.; sodium hyposulphite, 1 oz.; gold chloride, 1 gr. Over-exposed prints may be reduced by immersing in a weak solution of hydrobromic acid, a suitable strength being 30 drops of the strong commercial acid to 1 oz. of water. One immersion for a minute or two

will usually suffice; the print is then washed well. Another method is to immerse the print in the weak acid for a few seconds only, and then transfer to a weak fixing bath of "hypo" and water for a few minutes; this increases contrasts considerably, and much can be done in the way of getting good prints from weak negatives. As regards intensification, the image consisting practically of metallic silver, it can be subjected to the processes advocated for intensifying negatives and bromide prints, and even the uranium and sulphide processes of toning and intensification may be used. The kallitype print, unlike a bromide print or a negative, can be easily bleached in a solution of hydrochloric acid, and 10 drops of the acid added to 1 oz. of water rapidly removes the image and converts the silver into silver chloride. If the bleached picture is then well washed and exposed to a strong light, it may be developed with any clean working developer, as hydroquinone-metol, etc. In this way a strong developer may be employed to produce a cold tone, or a weaker developer one of a warmer tone, and the tones can further be modified in a gold or platinum toning bath.

KAMMATOGRAPH

An apparatus for taking and projecting kinematographic pictures, invented by Leo Kamm. A circular glass plate, 12 in. in diameter, is used as a support for the sensitive emulsion, at its centre being a hole about $1\frac{1}{2}$ in. in diameter, and the mechanism is such that the plate cannot race past the point at which it is required to be held momentarily stationary for purposes of exposure. The circular plate is given an intermittent rotary motion and also an horizontal displacement, which enables a series of pictures to be impressed upon it in a spiral form. The combined camera and projector is made in two patterns, both of the same size, but one taking 350 and the other 550 pictures on the disc. Each picture of the 550 series measures $\frac{1}{4}$ in. by $\frac{1}{16}$ in., while those of the 350 series are slightly larger.

The apparatus is fireproof, whilst the process of making the positive records from the negatives involves but little trouble, the printing of the positive images being done exactly in the same way as one would make an ordinary lantern slide—by contact, exposure, and development in one sheet. There is considerable novelty in the mechanism, but the principle of arranging pictures in a spiral form upon a disc is not new, this having been done by American and French inventors prior to the inception of the kammatograph.

Anthony's "spiral" lantern and Nelson's "spiral" camera may be mentioned here, although they were limited to a much smaller number of pictures in any one series.

KAOLIN (Fr. and Ger., *Kaolin*)

Synonyms, china clay, white bole. A native hydrated aluminium silicate which, when prepared, is a white powder that is used for clearing the silver bath and in the production of matt surface paper, and is added to emulsions for the same purpose. It is also employed in the manufacture of crayons.

KARTALINE

A modification of the crystoleum process in which the print is attached face downwards to glass for colouring. When coloured and removed, it is finished by varnishing.

KATA-POSITIVE

An obsolete name for a positive on an opaque base, as ivory, paper, etc. Positives upon glass, etc., were known as dia-positives.

KATATYPE (See "Catatype.")

KEITH'S PAPER PROCESS

A waxed-paper process (*which see*) introduced by Dr. Thomas Keith, of Edinburgh, in 1856; practically the same as Le Page's process.

KENNETT, RICHARD

Died 1896. Patented, November 20, 1873, a process for using gelatine instead of collodion combined with salts of silver. A prepared compound was cut into strips, washed to remove the free salts, and afterwards dried. In this state the "pellicle," as it was called, could be stored for use, and when required it was dissolved in water and plates coated with it in the usual way. Advertisements of the period stated that "R. Kennett is now issuing his patent sensitised gelatino-pellicle, in packets containing sufficient to make two, four or six ounces of emulsion, at one, two and three shillings respectively." In March, 1876, he placed "rapid pellicle plates" all ready for use on the market, but photographers failed to appreciate the extraordinary sensitiveness of the plates, as compared with the slow wet plates, and they invariably got fogged pictures, either on account of over-exposure or unsafe (yellow) dark-room lights.

KETONES

A class of substances derived from the secondary alcohols by a removal of two atoms of hydrogen, and distinguished by the divalent group CO united with two alkyl radicles, as in acetone CH_3COCH_3 , which is practically the only one of any photographic interest, and which is described under its own heading.

KEY

A print is said to be in a high key when there are few gradations of tone, none of which is very deep; it is in a low key when the few tones are all at the dark end of the scale.

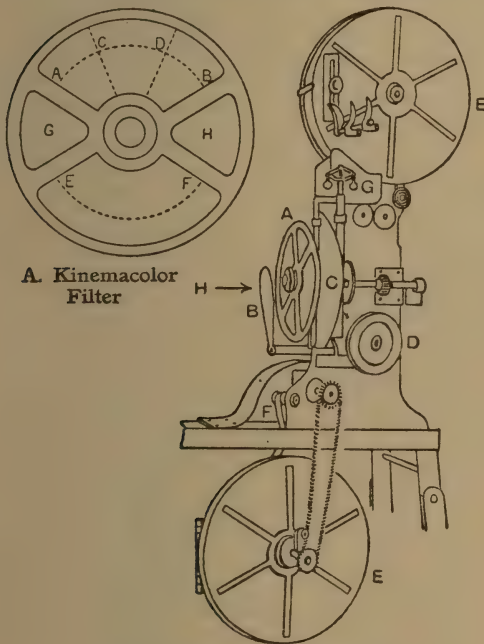
KILOGRAMME, KILOLITRE, KILOMETRE, ETC. (See "Weights and Measures.")

KINEMACOLOR

A system of producing kinematographic pictures in colour, devised by Charles Urban and G. Albert Smith. Only two colour filters are used, both in taking the negatives and in projecting the positives, but the projected pictures exhibit a remarkable range of intermediate tints, due partly to the fact that the green filter transmits a considerable amount of blue light, the pictures showing blue sky and water, besides black and white, and partly to the laws of persistence of

vision relative to colour perception. The camera resembles the ordinary kinematographic camera except that it is built to run at twice the speed, thus taking thirty-two images per second instead of sixteen, and that it is fitted with a rotating colour filter in addition to the ordinary shutter. This filter is an aluminium skeleton wheel A having four segments, two open ones, G and H, one filled in with red-dyed gelatine, E F, and the fourth containing green-dyed gelatine, A B. The machine is so geared that exposures are made alternately through the red gelatine and the green gelatine. The negative is printed from in the ordinary way, when the desired variations of tone become evident in the positive. (See a plate accompanying this work.) It will be understood that there is no colour in the film itself, which, indeed, resembles at first sight any ordinary kinematograph film; the filter is the medium by which the colour is obtained.

The projecting apparatus is shown at B. As in the camera, the mechanism is designed to work at double ordinary speed, projecting



B. Kinemacolor Projector

thirty-two images per second, sixteen being projected through the green segment of the colour filter A, and the other sixteen through the red segment. G shows the governing balls communicating with the safety shutter B, compelling the latter to drop out of the path of the lantern rays as soon as the film is passing at a safe speed through the apparatus. The arrow H indicates the direction of the light rays from the illuminant; C is a light guard, preventing stray light from passing to the screen; D the driving pulley, F the film, and E E safety spool boxes.

A special feature in the formation of the

colour filter must now be referred to. Supplementary to the green filter A B (in illustration A) an overlapping segment of green is filled from C to D with the object of obtaining balance of colour, since red is more vivid to the eye than green. The size of the supplementary segment, C D, is a matter of great importance if perfect results are to be obtained. If it is not large enough, the yellows will have a greenish hue; if it is too wide, the green will be too dense and the red will be in excess, giving to the yellow an orange hue. If the red and green filters have been rightly balanced, the revolving disc will transmit to the screen a neutral white "colour."

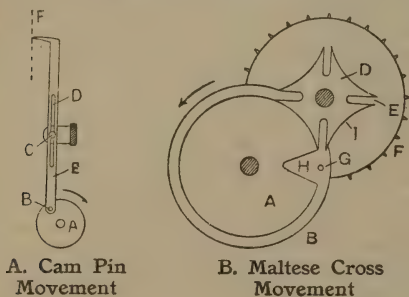
When taking the negative photographs, the speed of film through the camera must be maintained at 2 ft. per second, otherwise the object, when projected, will appear to move at an unnatural pace. Assuming a uniform rate of projection, increased speed of taking will cause an effect of abnormally slow motion in the projected pictures; while if the subject is taken too slowly, the projected images will show everything moving too fast. In addition to this, the too quick operation of the camera tends to under exposures and excessive vividness of colours, and too slow operating to over-exposures and dull results.

Turning now to the operation of the projecting machine, it will be understood that at the moment when a particular filter is opposite the optical centre, the monotone image belonging to that colour will be in the gate of the instrument and be projected upon the screen. The images following in this order at the high speed of thirty-two images per second, the combined effect upon the screen will be a picture reflecting not only red and green, but also their complementary or accidental colours intermixed with many other hues resultant from the blending of the red and green proper. Although the Kinemacolor system cannot be said to be absolutely perfect, it is the most successful system of colour projection combined with animated effects yet evolved. An ideal process would be that in which the three primary colours of the solar spectrum were embraced, taking the negative images through suitable colour filters and projecting positive images therefrom through yellow, blue and red filters; but at present the chemical, optical, and mechanical difficulties of doing this in a way that would meet conditions inseparable from kinematography are insurmountable. Not until the three requisite images are taken simultaneously and from a common optical view-point within the time-limit of persistence of vision, and the positives projected under similar conditions, can fully satisfactory results be expected.

KINEMATOGRAPH

A general outline of the whole process or manner of taking and projecting kinematograph pictures must be given to render intelligible a description of the necessary mechanism. Briefly, the camera consists of a light-tight chamber fitted at the top with a magazine for holding a long roll of negative film; a similar magazine at the bottom of the chamber for the reception of the film after exposure; mechanism for drawing

the unexposed film from the top magazine, passing it intermittently past the exposure aperture, and finally winding it up in the lower magazine; and an optical system for projecting the image upon the film. A negative obtained in this camera is taken under cover to a dark-room with the usual ruby illumination; wound on a frame, and developed in large tanks. After development and washing, the negative is wound on



large drums, provided for the purpose, in hot-air chambers. When dry, it is put through a contact-printing-machine, in which an unexposed film (the positive stock) is placed in contact with the negative film and the two run together with the celluloid side of the negative next to the illuminant and the positive film behind the negative, both in contact, gelatine to gelatine. The positive, or so-called print, is treated in the same manner as the negative, and dried on drums or on frames. When dry the films are ready to be exhibited, for which purpose projecting machines are required. All projecting machines in general use are built on the intermittent principle. The entire apparatus consists of an arc-lamp (sometimes a high-power limelight jet), lantern body, film mechanism, and optical system. Projecting consists in feeding the mechanism with a positive film from spools designed for the purpose, and winding it up as used, the images being projected upon a screen.

In many of the early kinematograph machines the film travelled through its requisite path from spool to spool with a continuous movement, whilst the optical system was made relatively stationary by following the motion of the film and being then brought back to its starting point with a jerk. In practice this was unsatisfactory, and it has been superseded by what is known as the "intermittent movement," according to which the film comes to a standstill for a fraction of a second and is held stationary during exposure. Three distinct methods are now in general use, namely, the pin movement, the dog movement, and the Maltese-cross movement.

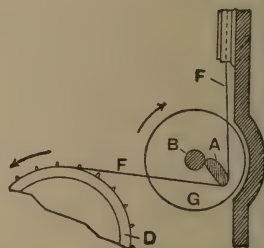
The three forms of intermittent movement will now be referred to. The pin movement mechanism is illustrated at A. A shaft E, slotted at D, and carrying a pin at the top, oscillates on a fixed point C. The lower end of the shaft E is pivoted at B to a cam A, which, on rotation in the direction of the arrow, causes the pin shaft to rise and fall, and at the same time to make a forward and backward move-

ment. The dotted line at F indicates the edge of the film, the alternate open spaces indicating the perforations. The figure shows the pin about to enter a perforation. On rotating the cam A, the pin will enter the perforation, and as the cam continues to revolve, the pin will pull down the film the distance of one picture space, being ultimately released as the revolution of the cam continues and brought into position for re-engagement with the film perforation. In practice, the cam A rotates sixteen times per second; hence the film will be moved sixteen times and as often allowed to remain stationary.

The Maltese-cross movement is shown at B. A sprocket-wheel F carries teeth which engage with the film perforations. Fixed to its side is a Maltese cross D. A disc B, carrying on its side a second disc A, and a pin at G, is made to rotate continuously in the direction of the arrow. During its motion, the pin G enters the slot E, and at a certain point begins to turn the Maltese cross; the points of the cross pass into the notch H of disc A and thus allow the sprocket-wheel to make one quarter revolution; then it is brought to a standstill and held steady by the concave edge I coming opposite to the convex plain edge of disc A. When disc A has made a complete revolution, the same action takes place, and so on, on each corner of the cross.

The dog movement, invented by Demeny, of France, and shown at C, has a disc G, centred at B, and carrying in a slot, so as to be adjustable, a semi-circular shaped pin A, which, on each revolution of the disc, comes into contact with the film F, drawing this down a distance of one picture space. The slack film is taken up by the continuously rotating sprocket-wheel D.

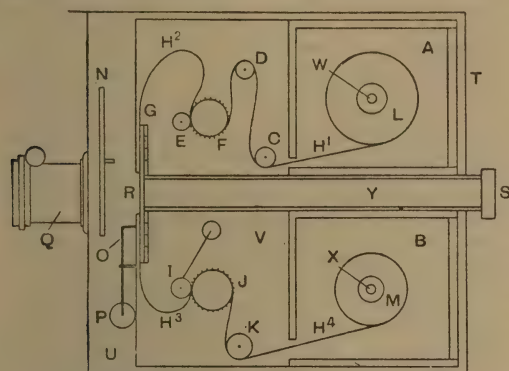
A diagrammatic view of the interior of a kinematograph camera is shown at D. The casing T is divided into three compartments: (1) A front compartment U, containing a rotating shutter N, pin mechanism O P, and other parts not shown; (2) a compartment V containing



C. Demeny Dog Movement

the film mechanism and magazines; (3) and a compartment on the opposite side containing further mechanism communicating with the spools in the magazines, with the sprocket-wheels and with the parts in the front compartment. The two magazines A B, consisting of light-tight boxes, fit into the back portion, and carry bobbins W X, on which the film is wound. This apparatus works as follows: The roll of unexposed film L passes out of a small aperture H¹ at the corner of the top

magazine A, round guide rollers C D, engages by its perforations with the sprocket-wheel F, to which it is kept in contact by the roller E, is looped up at H², and then takes a downward course through the guide groove made in the gate G; it passes out at the bottom of the gate, where it forms a second loop H³, and then



D. Diagram of Kinematograph Camera

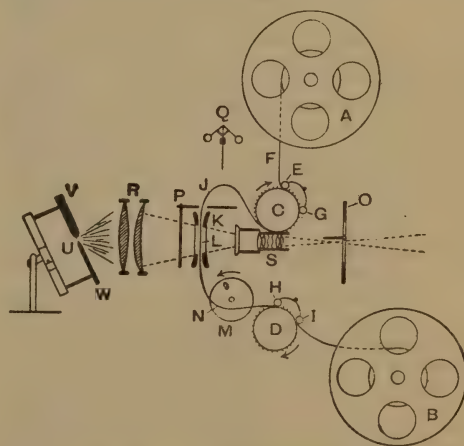
passes between spring-roller I and sprocket wheel J, under the guide roller K, and enters at H⁴ the bottom magazine B, where it is wound up on the bobbin X. The sprocket-wheels rotate continuously, drawing the film from the supply at I, and taking it up at M; the motion of the film in the gate G, however, is intermittent. During the period of rest, a surplus loop of film forms at H², which is then pulled down through the gate by the action of the pin O engaging with the perforations. The whole mechanism is so arranged and geared together that, just as the film is stationary, an open sector of the rotating shutter N comes opposite the lens and film aperture at R. Likewise, just as the film is making its intermittent move downwards, an opaque sector of the shutter N comes opposite the lens, so that being thus under cover, it is saved from being fogged. Through the centre of the camera and opposite the lens, a long tube V extends, with a detachable cap at S. This tube forms the sight hole for purposes of inspecting the image upon the film prior to exposure. The gate G is a kind of hinged door with an aperture in it, and its function is to keep the film flat and vertical during exposure, and also to act as a channel or guide. After taking a subject, the operator presses a button, and in so doing punches a hole in the film, at a point just above the gate, this enabling him to determine where one subject ends and another begins.

Each individual photograph requires an exposure of from $\frac{1}{30}$ th to $\frac{1}{100}$ th of a second, the shorter the exposure the better, provided there is sufficient light to produce a well-exposed negative. The lens must give really excellent definition. A slight lack of sharpness caused by movement of the object during exposure will not seriously injure the effect, but the stationary surroundings repeated in the successive pictures must be sharp. Rapidity in the lens is also a matter of importance; $f/6$ or thereabouts is sufficient for most purposes, and

at times $f/8$ or even $f/11$ can be used. The focal length will be short, so that the attendant defect of great rapidity, namely, lack of depth of definition, is not of great importance. The lens that is generally employed has a focal length varying from $1\frac{1}{2}$ in. to 4 in.

The lens that has been employed for taking the photograph is frequently used for its projection upon the lantern screen; this is a mistake, for a lens with the largest possible aperture, at least $f/4$, and better $f/3$, of the Petzval form should be used for projection, unless the lens is of more than 4-in. focus, in which case it is not of so much importance.

Projecting machines vary as regards type and method of translation of the film, but all of them work on the intermittent principle. The film is brought to a dead standstill sixteen times per second, whilst within the same space of time it is also moved forward in a vertical direction downwards sixteen times; this movement is accomplished at the moments when the opaque sector of the rotary shutter is opposite the optical system. The essential parts of a kinematograph projector are shown at E, the main support and the gearing mechanism being omitted. A and B are the two spools to carry the film before and after passing through the machine, the top one being the feed-spool and the bottom one the take-up spool. An upper and lower sprocket-wheel C and D engage with the perforations of the film F. The latter passes from A, between sprocket C and spring pressure rollers E G, forms a loop at J, passes through gate K, past the exposure aperture L, goes under the dog M, between sprocket-wheel D and pressure spring rollers H I, and finally to the take-up spool B. Sprockets C and D work in



E. Diagram of Kinematograph Projector

unison. A surplus loop of film is provided at J, as in the camera already described. The top spool A rotates by reason of the pull made on the film and is free to revolve accordingly. The lower spool B is turned continuously by a slip-belt, so that the film is tightly wound thereon, as it comes from the sprocket D; the slip-belt compensates for the constantly increasing size of the roll of film on B. The gate K

has springs and pressure pads which hold the film steady after its downward motion; and the channel through which it travels is recessed, contact only obtaining at the edges where the perforations are. The gate turns on hinges after the manner of a door, in order to facilitate insertion and threading of the film, being fastened by a catch and held by a spring. A revolving disc with open sector constitutes the shutter O, which is geared in such a manner that the open portion arrives opposite the exposure aperture and optical system just at that moment when the film is brought to rest. Finally, a safety drop shutter P is situated between the gate and condenser R, its rise and fall being controlled by the governor Q. The governor does not allow of the shutter rising till the mechanism is running at the rate of showing sixteen pictures per second, at which speed it is safe to allow the emission of the lantern rays through the celluloid film. The objective lens for throwing the image upon the screen is at S, between the gate and the rotary shutter. The lantern situated immediately behind the condensing lenses R contains the necessary source of illumination, an electric arc-lamp, the carbon pencils V W of which create the arc at U, at which point also a crater forms exactly in a line with the centre or axis of the optical system; or a limelight jet can be used.

The film is threaded through the projecting machine with the gelatine surface turned towards the condenser, and with the pictures inverted. If on projection it is found that the halves of two pictures appear on the screen, the pressure rollers H I are raised, and the film lifted forward till the sprocket teeth engage with two perforations in advance of its previous position. Another way is to raise or lower the gate K by means of the pinion and rackwork provided for the purpose, but the picture is not then always exactly opposite the centre of the optical system. Equally important, in order to get the picture as steady and life-like as possible, is that the handle should be turned with the greatest regularity and at the rate of two revolutions per second. (See also "Kammatograph," "Kinemacolor," and other headings.)

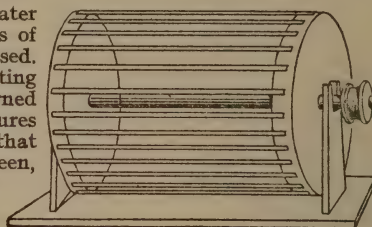
KINEMATOGRAPH PICTURES IN BOOK FORM

The fundamental principle of the kinematograph picture is based on the fact that if a series of complementary images be presented to the eye in such a manner as to satisfy the laws of persistence of vision, these images will combine and thus produce the illusion of a single impression. Further, if each image or picture in such a series be slightly different, according to the changes presented by a moving object, the complete scene will have the semblance of life. These conditions are fulfilled in a primitive way by depicting on successive leaves of a book the phases of the subject it is intended to present, and then allowing the leaves to escape rapidly in succession.

KINEMATOGRAPHY

The art of photographing objects in motion and projecting the images upon a screen. It

derives its origin from a toy called the "zoetrope" and depends for its results on what is known as "persistence of vision." When light is reflected from a moving object it forms an image on the retina (or sensitive plate) of the eye, and creates a nerve current which passes along every one of the fibres which receive the image and collectively carry the impression through the optical nerve to the brain. This sensation may be divided into four periods: First, a latent period which is almost instantaneous, and during which nothing seems to happen; second, a very short period, estimated at less than $\frac{1}{100}$ th of a second, during which the sensation reaches the maximum; third, a much longer period, $\frac{1}{30}$ th to $\frac{1}{10}$ th of a second (varying according to the power of illumination) during which the sensation slowly diminishes; and, fourth, a short period of decline, during which the effect dies away. It is found that in the case of a moving object on which attention is directed the fourth period remains unnoticed, owing to the fact that a new image takes up the place of the old one before that period begins. Prof. Tindall estimated the time of persistence of an impression on the retina to



A. Skeleton Drum for Drying Film



B. Frame for Negative Film

be $\frac{1}{10}$ th of a second, that is, the impression remains for $\frac{1}{10}$ th of a second after the source of excitation is removed. Upon this all kinematograph apparatus is based.

The kinematograph camera and projecting apparatus are described under the heading "Kinematograph."

The three chief requisites to final success are: (1) A photographic emulsion sufficiently sensitive to receive latent impressions at the rate of sixteen per second; (2) optical systems capable of forming the negative images in the camera and the positive image upon the lantern screen; and (3) mechanical means for suitably translating the films through the camera and afterwards through the projector.

The emulsion is supported on celluloid cut into ribbons $1\frac{1}{2}$ in. wide, and in lengths of about 150 ft. The inner portion of the surface, 1 in. in width, is devoted to the pictures, the margins being used for the perforations by means of which the film is held in position during its progress through the camera or projector. Each image is 1 in. wide, and $\frac{1}{2}$ in. high, there being sixteen pictures to 1 ft., and four perforations on each side per picture. Slightly thicker celluloid is used for the positive film than for the negative, the former being subjected to more wear and tear than the latter.

Having decided on the type of camera to be

employed and the make of negative stock film to be used, the operator may proceed to work much in the same way as he might when taking ordinary snap-shot photographs in an ordinary magazine film camera. The negative stock film can be obtained in rolls of 150 ft. in length, ready perforated, and supplied in sealed tins, in which it is wrapped in lead sheets and light-tight paper. The magazines A B (*see* D, p. 319) are detached, and the unexposed film opened in the dark-room, with ruby light, and placed in magazine A, the centre of the roll being slipped over the bobbin w. The starting end of the film is drawn through the small aperture at the corner of the magazine, and the lid secured. The short length of the film projecting at the corner serves as lead film to facilitate drawing out, when it is desired to thread through the camera mechanism just before actual operations. When about to make the exposures, the side of the camera is opened and the film threaded as indicated at D (p. 319), taking care to arrange for the loop at H² and at H³. The bobbin x has a clip which holds the end of the film securely. The lid of the magazine B is, of course, removed during these operations, and the length of film extending from c is unavoidably fogged. The operating handle of the camera should be turned a few times in order to make sure that everything is working properly; then the lid of B and the side of the camera may be closed. It now remains to see that the picture is sharply focused and, to do this, the handle should again be turned so as to bring an unexposed portion of the film opposite the exposure aperture R, and at the same time cause an open section of the shutter N to arrive in a line with the lens. By removing the cap s from the sight tube v, the operator may now have a view of the image on the film. If a focusing scale is provided on the lens itself, this operation is, of course, unnecessary; a separate view finder is provided on the camera. See that the cap s is replaced. The handle must be turned at the requisite speed, and as the mechanism is generally geared to make eight exposures for each complete turn of the handle, two turns should be made per second. Too fast camera operating will result in abnormally slow motion of objects in the projected picture, and vice versa. The most important point is the question of steadiness, for if the camera has been allowed to vibrate during the work of turning the handle, no afterwork can rectify such an error. Manufacturers supply very rigid and somewhat heavy stands for the camera. The screw holding the camera to the stand should be very tightly fastened. (*See also* "Theatrical and Kinematograph Photography.")

Development of kinematograph films is carried out in precisely the same way as that of ordinary film negatives; but some special appliances are necessary. The frame B is one. The pins top and bottom serve to hold the film in place, it being wound in spiral fashion and secured at each end by clips or drawing-pins. The emulsion side is turned outwards, so that only the celluloid surface comes into contact with the frame. A tank sufficiently large to take the frame is provided for the developer, another for the fixing solution, and a third for washing

purposes. The latter is furnished with a siphon overflow so that proper circulation of the water is secured; a tap provides a constant supply of fresh water at one end of the tank, the overflow siphon being situated at the opposite end. The washed film is wound on a skeleton drum A in spiral fashion, and placed in a warm room free from dust, and kept rotating for fifteen minutes. When the emulsion is thoroughly dry, the cleaning process is carried out, all finger marks being polished off from the celluloid side by means of a pad of soft material fixed to a bench over which the gelatine surface may pass without injury. A hole cut in the bench, through which the light of an incandescent electric lamp is directed upwards, enables the cleaner to detect smears and other marks. The film is wound up into coils by means of special winders.

The positive film is made by contact printing from the negative. Special machines are provided for the purpose, in which the action of the mechanism is approximately the same as that in the camera. Exposed positive stock is developed, fixed, washed and cleaned in the same manner as the negative.

If through accident a subject becomes broken in the middle, cutting out should be done so that when the two ends are rejoined, pictures follow on consecutively as before the accident. The ragged part of one end should be cut away exactly at the juncture of two pictures, and the end to be joined thereto should have an $\frac{1}{4}$ th portion of a picture left on. The gelatine on this $\frac{1}{4}$ th part should be removed, leaving the bare celluloid exposed. Film cement is then applied with a brush to the scraped-off portion, and this is quickly laid against the celluloid backing of the piece to be joined, firmly pressed, and allowed to dry. The cement dries within a few seconds after application. See that the perforations on the overlapping portions of the film exactly register. The blank spacing of film subjects is a source of many troubles if not correctly carried out. There are four perforations each edge to each picture and any length of blank film joined between succeeding subjects should correspond in length to a given number of complete pictures; otherwise, it will be necessary to make an adjustment in the machine when projecting.

KINETOSCOPE

Edison's apparatus for exhibiting his "kine-tographs," pictures on a continuous band of film lighted by an electric lamp behind them.

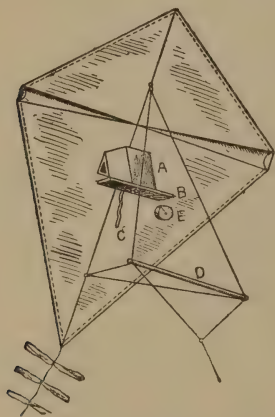
KINOCYANINE

A developing agent discovered in 1891 by Noël, a French chemist, whilst preparing kyanol or bleu de Paris; so called because of its similarity to vegetable cyanine and quinone. $C_{26}H_{12}C_{10}$. It takes the form of an amorphous powder or ill-defined small crystals of a bluish violet with grey tinge. The original formula is:

Sodium sulphite	.	.	50 parts
Sodium hydrate	.	.	1 part
Sodium carbonate	.	.	140 parts
Kinocyanine	.	.	10 "
Water	.	.	1,000 "

KITE PHOTOGRAPHY (Fr., *La photographie par cerf-volant*; Ger., *Drachenphotographie*)

Photography by means of a camera attached to, or suspended from, a kite is of frequent use in obtaining bird's-eye views for military purposes, and as an aid to the surveyor and meteorologist. A. Batut, of Enlaure, France, was the first to devote special attention to this class of work. In 1887 he employed a large diamond-shaped kite, as illustrated, having a long tail to give stability. The camera A was fastened to the kite by a triangular support, and had a shutter B of the guillotine type, working horizontally by means of two rubber bands. The shutter was held in tension by a thread, which was burnt through by a slow fuse C, ignited before flying the kite. In its passage across the lens the shutter was made to release a paper streamer, thus announcing that the exposure had taken place. Flat films were used. To prevent obstruction of the view by the cord, this was attached by a kind of double bridle to



Camera attached to Kite

a bar D. A self-registering barometer E indicated the height attained.

E. Wenz, in Germany, used shortly afterwards a kite of similar shape, but with the camera fastened to the bridle cords. Since then, kite cameras of a much more elaborate kind have been employed. As an example may be mentioned one made in 1899 by L. Gaumont, of Paris, for the use of A. Lawrence Rotch, of the Blue Hill Meteorological Observatory, near Boston, Massachusetts. While primarily intended for photographing the under surface of clouds, this could be employed also for obtaining views of the surrounding country. Clockwork allowed of successive exposures on a roll of film at predetermined intervals. Electric releases and simple cord releases operated from the ground have also been used.

The kite employed for photographic purposes must be steady in the air, the box kite and the multicellular oblique type being now preferred to the older pattern. The camera, which should be as light as possible, and of the fixed-focus box-form variety, carrying films, is now usually

attached to, or hung from, the cord. A simple method of making the exposure, suitable for experimental use, is as follows: A rubber band, one end of which is fastened to a small staple, is stretched over the trigger release of the shutter, and the latter is set back against the pull of the rubber by a thread tied to another staple as far away from the lens as possible. A sufficient length of ordinary wool soaked in a strong solution of potassium nitrate and dried is then tied to the further end of the thread, and ignited when the kite is ready to be flown. The slowly-burning fuse will eventually sever the thread, and thus enable the rubber band to work the trigger release of the shutter.

KLIC PROCESS

The process of photogravure (*which see*) as invented by Karl Klic, of Vienna.

KNIFE, RETOUCHING

A small knife of any convenient shape used for reducing the over-dense parts of a negative by cutting or scraping, for which purpose the film must be bone-dry and the light particularly good. The work must be done gently.

KNIFE, TRIMMING (*See "Trimming Prints."*)

KODAK

A trade name which is so familiar that many suppose it to apply to all hand cameras, although, as a matter of fact, the Courts decided in 1903 that it is the registered property of one particular company.

KOENIG'S COLOUR PROCESS (*See "Pina-chromy."*)

KRÖHNKE'S INTENSIFIER

A method of intensification without mercury, advocated by Herr Kröhnke. The negative is made yellow in a .3 per cent. solution of iodine and potassium iodide in water, washed, and made brown by flooding with a solution of Schlippe's salt, 15 grs.; caustic soda (10 per cent. solution), 2 to 3 drops; and water $3\frac{1}{2}$ oz. Finally, the negative is washed and dried, the process being claimed to give clear shadows and to remove entirely any yellow stain.

KROMAZ

The viewing instrument used in connection with a process of stereoscopic colour photography invented by Barnard and Gowenlock, in which different colours were viewed by each eye.

KROMOGRAM

A name given to the transparencies used in the Ives Kromskop.

KROMSKOP

The name given to two forms of apparatus invented by Frederick Ives for projecting photographs in natural colours. Three slides taken through certain filters are simultaneously projected to give the effect of a single picture, there being for each slide a colour filter, respectively red, green, and blue-violet.

KRUSS CAMERA (*See "Magic Camera."*)

L

LABARRAQUE'S SOLUTION

Another name for "eau de Javelle" (*which see*).

LABELLING BOTTLES

Special care is necessary in labelling bottles that are to contain photographic chemicals. First make the outside of the bottle perfectly clean and dry; use gummed labels, or attach by means of liquid gum, and smooth into close contact. When quite dry, write on the label with ordinary or waterproof ink, or even with pencil, which is more permanent than some inks. Coat, when dry, with size made by dissolving $\frac{1}{2}$ oz. of common glue in $2\frac{1}{2}$ oz. of water, and when this is dry apply a thin coat of oak or hard carriage varnish. A label varnish much used in laboratories, etc., is the following:—

Sandarac	$2\frac{1}{2}$ oz.	78 g.
Mastic	1 "	31 "
Camphor	24 grs.	1.5 "
Oil of lavender	$3\frac{1}{2}$ drms.	12.25 ccs.
Turpentine	2 "	7 "
Ether	3 "	10.5 "
Alcohol	$2\frac{1}{2}$ oz.	8.75 "

Macerate for several weeks, agitating until dissolved.

A less efficient method is to attach the paper label in the usual way, warm it, and smear with wax by rubbing with the end of a candle. Another plan is to coat the attached label with celluloid varnish, made by dissolving celluloid (old films will serve if the gelatine is cleaned off) in acetone, amyl-acetate, or methylated spirit.

The bottle itself may be written upon, using one of the inks given under the heading "Ink for Glass, Porcelain, etc."

There are many special recipes for pastes for attaching labels to chemical bottles. Caustic soda and nitric acid are sometimes included with the object of breaking up the starch granules, and alum and sugar to increase the adhesive properties. One of the best of the many formulæ is:—

Wheat flour	2 oz.	220 g.
Powdered alum	160 grs.	37 "
Cold water	10 oz.	1,000 ccs.
Formaline	40 drops	8.5 "

Mix the first three ingredients together, boil in an enamelled saucepan, and when cold stir in the formaline.

In America it is common to label flat bottles in the following way. A strip of glass is cut $\frac{1}{8}$ in. narrower than the flat side of the bottle, and the paper label should be about $\frac{3}{8}$ in. smaller than the glass strip. The written side of the label is pasted to the glass strip, the edges of which are then smoothed. Both bottle and strip are then warmed, and the two attached together with a cement made by melting 1 part of beeswax with 3 parts of resin.

Names may be etched on bottles and the etching left plain or filled with Brunswick black or other pigment. Mix up the two following solutions:—(1) Sodium fluoride, 36 grs.; potassium sulphate, 7 grs.; distilled water, 2 oz. (2) Zinc chloride, 14 grs.; hydrochloric acid, 65 drops; distilled water, 1 oz. Mix the two solutions and write on the bottles with a quill or camel-hair brush; leave for about five minutes and then wash off.

LABELLING TINS

It is more difficult to attach paper labels to tins than to bottles. A plan that is often recommended is to gum the label in the usual way, but before attaching it to rub the part of the tin where the label is to go with a piece of freshly cut onion. Another method is to use a piece of fixed P.O.P.; write on the plain side and then wet the gelatine surface and place in contact with the tin. It is desirable to use waterproof ink and to varnish the labels.

LABELS, POLYGLOT

These are a convenience to the travelling photographer, but hardly a necessity, as English or French inscriptions are sufficient for the Customs authorities practically all over the world. The following is a polyglot label for a box of dry plates, the only photographic material that there should be the slightest desire to label in this way:—

English—Photographic Plates. Sensitive to light. *France and Belgium*.—Plaques Photographiques. Craint la lumière. *Germany and Austria*.—Trockenplatten. Nur bei rothem Licht zu öffnen. *Holland*.—Droge Platen. Slechts in sene donkere kamer te openen. *Denmark*.—Tørreplader. Maa kun aabnesi mørkkammaret. *Norway*.—Fotografplader. Maa kun aabnes vid rothlys. *Sweden*.—Törreplåtar. Oppnas endast i mörktrum. *Finland*.—Walokuvauslevyja. Saapi avata ainoastaan pimeässä huoneessa. *Italy*.—Lastre Fotografiche. Teme la luce. *Spain*.—Placas Fotograficas. No abrir sino en el cuarto oscuro. *Portugal*.—Chapas Fotograficas. So se deve abrir n'um quarto escuro.

LABELS, WATERPROOF INK FOR

Dissolve in 2 oz. of hot water $\frac{1}{4}$ oz. of borax, add $\frac{1}{4}$ oz. of shellac, and simmer gently until as much of it as possible has dissolved. When cool, decant the clear liquid and mix with Indian ink or finely powdered lampblack to a suitable consistency.

LAC (*See "Gums and Resins."*)

LACMUS (*See "Litmus."*)

LACTIC ACID (Fr., *Acide lactique*; Ger., *Milchsäure*)

$C_3H_5O_3$ or $CH_3CH(OH)COOH$. Molecular weight, 90. Miscible in all proportions with water and alcohol. A colourless, thick liquid, obtained from sugar by the lactic ferment, and used in the platinum toning bath.

LAMBERTYPE

A carbon print with an enamelled surface. A glass plate is polished with a solution of 5 grs. of beeswax in 1 oz. of benzole and is then coated with enamel collodion and dried. The exposed carbon tissue is squeegeed on the plate, developed in the usual way, and the final support for the tissue is squeegeed into contact. When quite dry the collodion-supported image is detached from the glass.

LAMPLIGHT EFFECTS

Lamplight scenes which do not include figures present no difficulty, providing a sufficiently long exposure can be given. Out-of-door lamplight effects are described under the heading "Night Photography." Indoor lamplight effects, with figures, may be obtained by concealing a piece of magnesium wire in the lamp, which is preferably provided with a globe or shade, or by having the magnesium in such a position as to give the effect of the light coming from the lamp, as described in the article, "Candle-light Effects."

Daylight can also be used, and the following is H. Essenhigh Corke's method. An imitation or dummy lamp is used. First, a real lamp, alight, is photographed and the image enlarged to the same size as the lamp. The enlargement is mounted on cardboard, which is then cut to the outline and a strut placed at the back. The dummy lamp can be placed anywhere in the scene, and in the finished photograph cannot be told from a genuine lamp. The lamp and sitter are arranged near a window, of which all except a small space is blocked up in such a way that a strong light appears to come from the lamp and fall upon the sitter, the light tones graduating into darker ones on parts of the drapery and surroundings. The "lamp," being of thin cardboard, does not throw a perceptible shadow; but a certain amount of light must fall upon its face, in order that the details may be shown. It may be necessary to use reflectors, as in ordinary portraiture. For lamplight effects it is more natural to retain almost all the shadow detail, and not, as in firelight effects, regard only the high lights and half-tones. Exposure will vary, and must be a matter for experiment. The prints should be stained with an orange-coloured dye, such as eosine and methyl-orange aniline colours, or carbon prints on a suitably coloured support may be made.

LAMPS, ARC (See "Arc Lamps" and "Electric Light.")

LAMPS, DARK-ROOM (See "Dark-room Lamp.")

LAMPS, MAGNESIUM (See "Flash Lamp.")

LAMPS, SPIRIT (See "Spirit Lamps.")

LANDSCAPE, CLOUDS IN

Clouds in landscape photographs not only fill a space that might otherwise be blank, but they form an essential element in completing a picture, in its composition, and its balance of light and shade. Careful attention must be given to the depth or general tone of the sky, and also to the intensity or contrast in the clouds themselves. Clouds may appear brilliant to the eye, but it must be recognised that their scale of tones is short when compared with that of the landscape. When clouds are included successfully on the same plate as the landscape, their depth of tone may be made to harmonise with the landscape by the methods given under the headings "Harmonising Contrasts" and "Control in Printing." When they are printed in from a separate negative (see "Clouds, Printing in"), the depth of printing can be controlled so that they may still appear to be in harmony with the tones of the landscape. A common fault is the rendering of clouds much too strongly, in tones that are too heavy or too brilliant for the picture. The forms of the clouds and their grouping are frequently of the greatest value in completing the composition of a picture, especially in simple subjects that consist of a few well-defined masses, and have, in addition, a large proportion of sky. The masses of cloud may form a line that will balance or harmonise with the principal lines in the picture, or the clouds may be so grouped that their principal points or lights may balance the chief point of interest in the landscape.

LANDSCAPE, FIGURES IN (See "Figures in Landscapes.")

LANDSCAPE LENS (See "Lens.")

LANDSCAPE PHOTOGRAPHY

In modern landscape photography the hand camera has naturally taken a very prominent place, but it must be recognised that the best work in landscape photography results from studying and arranging the picture on the focusing screen, this generally involving the use of a stand. As on many occasions good subjects can be obtained when the use of a stand and the deliberate arrangement of the picture are impracticable, a "hand or stand" camera is the most convenient for landscape work. At times, a picture may be studied on the focusing screen, the best point of view selected, and then the exposure made when all the conditions are favourable by holding the camera in the hand. This method is specially applicable to village scenes, and occasionally to landscapes with animals.

For general landscape photography the camera should have a rising front, a swing back, and should be capable of extending to twice the length of the plate. In all positions it should be quite firm and rigid. The tripod should be firm and capable of adjustment to any height from 3 to 5 ft. The lens should preferably be a modern anastigmat with a full aperture of $f/8$; this will cover the plate with uniform sharpness without reducing the aperture, and at $f/11$ the rising front may be used to a considerable extent without loss of definition. The best proportion

of focal length is about $1\frac{1}{4}$ times the longer side of the plate, this giving good perspective effect without unduly dwarfing the distance. A lens of longer focus prevents many subjects from being composed satisfactorily, owing to various obstacles making it impossible to take a point of view sufficiently far from the principal part of the subject to secure a satisfactory proportion; while a lens of short focus has a tendency to exaggerate the difference between the near and distant parts of the picture. At times, however, a wide-angle lens having a focus a little shorter than the longer side of the plate is very useful, especially when the subject includes tall trees or high buildings and the space is limited. The shutter should be of the "time and instantaneous" pattern; and it is desirable that all exposures of less than five seconds' duration should be made by the shutter rather than by the cap. It is difficult to make a short exposure by means of the cap in brilliant sunshine without causing slight fog through the sun striking the photographer's hand, and being reflected into the lens when removing or replacing the cap; with a shutter there is no such risk. At times, too, the wind is very troublesome, and it is necessary to wait patiently for foliage to be reasonably still, even for an exposure of one second. With a shutter provided with a pneumatic or an Antinous release, the photographer can watch the moving foliage carefully, and as soon as the conditions are favourable for making the exposure he can press the bulb without turning or giving any attention to the camera. By pressing and releasing the bulb of a shutter set for "time" as quickly as possible, an exposure of a quarter of a second can be given, this allowing of photographing figures in the mid-distance, moving slowly towards the camera, without showing movement. The plates used should be rapid, and be backed.

It is in the selection, the arrangement and the method of treatment of a subject that the photographer shows his individuality. A feeling for composition is essential for successful landscape photography. The necessity for composition arises from the fact that the photographer takes a small portion of the landscape and encloses that portion in an artificial boundary composed of four lines forming a rectangle. It is essential that the small fragment of the landscape should convey the impression that the photographer desired to express, and one of the first conditions is that attention should be drawn from the boundary lines and into the picture towards the principal part of the subject. Every picture should consist of foreground, mid-distance and distance, the principal object or point of interest being in the near mid-distance. This will naturally demand primary attention, but the foreground requires almost as much. Most landscape photographers pay too little attention to the foregrounds of their pictures, thereby sacrificing much of their quality. In the foreground the gradations of light and shade are much more strongly rendered than in any other plane; and this strength has very great value in giving the effect of atmosphere and in causing the other planes to recede and take their correct position.

In selecting the point of view, it should be

remembered that the lower the point of sight the more the foreground is shortened, and small foreground objects appear more important; while a very high point of view will frequently give the impression of the ground running uphill.

Reducing the aperture of the lens becomes necessary in almost all landscape photography to secure sufficient sharpness of definition in the various planes. The nearer the foreground to the camera, the smaller will be the stop necessary; but the shorter the focus of the lens, the greater will be the range of distances that can be rendered sharply with a given value of stop.

Sunshine is very effective in most landscape work, especially when striking shadows break up an uninteresting foreground, or cause unequal lighting of the important and unimportant parts of a subject. Frequently, an oblique light—strong sunshine almost at right angles to the direction of the view—is very impressive.

LANGE'S DEVELOPER

The "washing soda" or "dry pyro" developer once popular; recommended by Paul Lange, of Liverpool, in 1890, for developing "snapshots" taken on ordinary plates. It is still a favourite amongst many photographers, who have no objection to yellowish negatives, and who prefer to add dry pyro at the time of use. The formula is:—

Washing soda	. 2½ oz.	137.5 g.
Potass. bromide	. 25 grs.	3 "
Water (boiling)	. 20 oz.	1,000 ccs.

For developing a quarter-plate, to $\frac{1}{2}$ oz. of above, add $1\frac{1}{2}$ oz. water, and 2 to 4 grs. of pyro, according to density required.

LANTERN

By this term is nearly always meant the optical or projecting lantern, for which, *see* "Enlarging Lantern" and "Optical Lantern." For the opaque lantern, *see* "Aphengescope." Many dark-room lamps are actually lanterns.

LANTERN PLATES

Specially prepared plates used for making lantern slides, and much slower than those used for negative work. In their manufacture the one object in view is their capacity for producing a clean and sparkling image of good gradation, with a very transparent character of the deposit of silver. The British standard size is $3\frac{1}{4}$ in. by $3\frac{1}{4}$ in.; American and Continental, 4 in. by $3\frac{1}{4}$ in. But in both cases the slide is usually masked to give an image not exceeding 3 in. by 3 in.

There are two distinct kinds of lantern plates: (1) ordinary, for contact printing by artificial light and for reduction in the camera by daylight or artificial light; and (2) "gaslight," for contact printing only. The former must be manipulated in the dark-room illuminated as for bromide paper; the latter may be developed, etc., in weak white light, the same as gaslight paper. For details of working, *see* "Lantern Slides."

LANTERN SLIDES

Transparent positives, for projecting by means of the optical lantern, are made in England

to a standard size of $3\frac{1}{4}$ in. square. Specially prepared slow plates are used, the object being to secure a fine transparent quality in the image, combined with good rendering of gradation and cleanliness in working. A good slide should be very transparent; that is, there should be an absence of any tendency towards clogging or opaque appearance; the deepest shadows should be strong so as to give a rich colour when projected. There should be scarcely any part absolutely white or free from deposit, and the range of gradation should be as perfect as possible, with full detail in both light tones and shadows.

Plates of two kinds are used. One corresponds in speed and character with the papers used for developing in weak gaslight, while the other is similar to a slow bromide paper in speed, but differs materially in character. The first kind will be considered later. For the second kind a yellow light is the most satisfactory when developing, etc., and there is a wide range in speed, the faster varieties yielding black tones only, while the slower ones give readily any tone from warm brown to black by simple modifications in exposure and development. These plates are sufficiently rapid for producing slides by reduction in the camera by daylight or artificial light, using a condenser in the latter case; or they may be employed with equal facility for contact printing by artificial light. An ordinary camera is employed for making slides by reduction in daylight.

Any adjustable camera may be used, provided that it is not smaller than $3\frac{1}{4}$ in. square. There must be a frame to hold the negative parallel with the sensitive plate, and at a suitable distance in front of the lens. In adjusting the distances of the various parts of the apparatus, the same proportion of the focal length of the lens will be required as in enlarging, but with this difference: the greater distance will be that between the lens and the negative; the smaller, the distance from the lens to the sensitive plate on which the image is produced. The space between the lens and the negative must be covered in so as to exclude as much extraneous light as possible, or the slides will suffer considerably, both in gradation and brilliancy. The apparatus should be pointed towards a window, preferably one that commands a clear sky view, in the same manner as in enlarging by daylight.

In making slides by reduction in an artificial light enlarging apparatus, the only difference in setting will be the distance from the lens to the easel and the extension of the camera body, these distances being the same proportion of the focus of the lens as in enlarging by daylight. With some enlarging lanterns in which the source of light is an incandescent gas mantle there is much greater risk of an image of the mantle being projected on to the easel in reducing for slide making than in enlarging. This can be entirely prevented by interposing a piece of ground glass between the condenser and the light.

Definite data for exposures cannot be given. With the slowest of the plates suitable for camera reduction, the exposure may range from fifteen seconds on a clear spring day, using $f/16$, and a thin negative, when working for black tones, up to as much as eight times as long for warm colours. Strong negatives will require much

longer, and some of the more rapid plates will be fully exposed with one-fourth of these times. For artificial light, as described, these exposures would be correct if $f/8$ were the lens aperture used.

For contact printing, magnesium ribbon forms the best illuminant, especially when warm colours are desired. The colour and quality of the light influence the colour produced by development. For black tones, 1 in. of ribbon at a distance of 6 ft. will be sufficient for a medium or thin negative, or 4 in. at 3 ft. will yield a good warm tone.

The colour of the image depends on two factors, exposure and development. The minimum exposure that will produce a well-graded image with sufficient strength in the shadows and full detail without any mass of clear glass in the high lights is that which must be given for pure neutral black tones. For a warm black, the exposure must be doubled, and for various tones of brown, deep or rich, from four to eight times the minimum exposure will be necessary. The exposure may be increased even beyond this with some plates, very warm brown and red-brown colours being obtained by increasing the exposure up to sixteen times the minimum. For neutral black tones any of the developers given for bromide printing will give the best result. For warm black and brown, pyro and soda will give excellent transparency and quality. Potassium bromide will be found the best restrainer. Most of the additions suggested by some photographers for obtaining warm tones clog the shadows and produce a semi-opaque deposit that spoils the effect of a slide when projected. Potassium bromide added liberally will produce the same degree of warmth combined with great transparency and fineness of quality. Other developers may be used instead of pyro by adding potassium bromide in the same way.

The following are typical formulæ, the developer being prepared from the usual stock solutions:—

For deep brown tones—

Pyro	15 grs.	3.5 g.
Potassium bromide	$7\frac{1}{2}$ "	1.75 "
Sodium carbonate	60-120 "	14-28 "
Sodium sulphite	60-120 "	14-28 "
Water	10 oz.	1,000 ccs.

For rich brown tones—

Pyro	15 grs.	3.5 g.
Potassium bromide	15-30 "	3.5-7 "
Sodium carbonate	60-120 "	14-28 "
Sodium sulphite	60-120 "	14-28 "
Water	10 oz.	1,000 ccs.

Begin with a small quantity of the sodium carbonate solution, increasing to the larger amount if necessary. Development will take from six to twelve minutes. If the development is begun in the more highly restrained solution, and the exposure should prove to be insufficient, the plate may be transferred to the less restrained, and a good slide should result; and, if development is begun with a small quantity of sodium carbonate, and this should prove insufficient, adding more will not detract from the quality of the slide, but will modify the colour. This method of working allows very great latitude in exposing, as the

development may be modified, during its progress, to suit the exposure.

After development, the plate should be washed in two or three changes of water and then fixed, preferably in an acid "hypo" bath containing 1 oz. of potassium metabisulphite to 1 lb. of "hypo," diluted so that 1 pint of solution will contain 3 oz. of "hypo." The plates should remain in the fixing bath for ten or twelve minutes. The developer for use with plates that are developed in weak gaslight is the same as that given for gaslight papers. Restraining by means of bromide may be adopted for securing warm tones. The same pyro developer may be used, or an equally large proportion of bromide may be added to an amidol or other developer. With these plates a longer range of tones may be secured, a good red and red-brown being easily obtained by increase of exposure and restraining. The image produced on these plates is exceptionally transparent and fine in grain. Even when strong, the image presents the appearance of a stain rather than a deposit.

The clearing of lantern slides should be unnecessary, if an acid fixing bath is used; otherwise proceed as explained for negatives under the heading "Clearing Solutions."

LANTERN SLIDES, DIAGRAMMATIC

Lantern slides of diagrams and other line subjects may be made in many ways, as, for example, the following: (a) Copying through the camera and printing the slide by contact from the negative; (b) printing from the drawing itself, which serves as a negative; and (c) the use of specially prepared glasses on which the diagrams may be drawn direct and serve as slides.

(a) The copying of the diagram through a camera is advisable in most cases, because the image can be reduced if necessary so as to come well within the limits of a lantern slide. Take care to obtain strong contrasts—the whites opaque and the lines clear. Should it be desired to show the diagram reversed as regards white and black—that is, white lines upon a black ground—the negative itself may be cut down to $3\frac{1}{4}$ in. square and used as a slide, or the diagram may be copied on a lantern slide direct, through the camera.

(b) The second method is of particular service when drawings are to be made specially for lantern slide work. A piece of white paper, thin and comparatively grainless, is cut to the size of a lantern slide. The drawing is then made on the paper in black ink, and used as a negative, a lantern slide being placed in contact with it and printed in the usual manner. The slide will show the blacks and whites reversed. Should a black line slide be required, the slide just prepared may be used as a negative and another slide printed by contact from it.

(c) This is not strictly a photographic process. Plain glass plates are coated with ground glass varnish, made as follows:—

Sandarac . . .	100 grs.	23 g.
Gum mastic . . .	100 "	23 "
Methylated ether . . .	10 oz.	1,000 ccs.
Benzole . . .	2 "	200 "

When dry it gives a surface which takes the pencil well, and any drawing or writing may be

made. The slide may then be made transparent again by flooding with:—

Sandarac . . .	150 grs.	34 g.
Gum mastic . . .	150 "	34 "
Methylated ether . . .	10 oz.	1,000 ccs.

which destroys the grain and leaves the drawing on what appears to be plain glass. Another plan is to use a special ink (*see* "Ink for Glass, etc."), while another is to use the finest ground glass obtainable, and after making the drawing, to destroy the grain by coating it with gum dammar dissolved in benzole. If white lines on a black ground are wanted, plain glass plates may be smoked by holding them over burning camphor, or by coating them with Brunswick black or other opaque pigment, and then scratching with a needle-point.

LANTERN SLIDES, MASKING, BINDING, AND SPOTTING

When a lantern slide is developed, fixed and washed, it requires finishing in such a manner that it can be shown effectively in the lantern, and handled without injury. The picture requires masking, that is, the portion of the plate not required needs to be covered with opaque paper, so that the picture is isolated on a dark screen, the edges being sharp and true as in a well-trimmed print. Lantern-slide masks are obtainable with openings of various shapes and sizes, but a serious worker soon finds it difficult to adapt them to his requirements. A print should be trimmed to a nicety, so as to include the amount of subject desired, and no more. Using commercial masks is like using untrimmed paper of a uniform size for prints; while it might answer in many cases, it fails frequently. A favourite plan with some workers is to cut a number of slips of thin opaque paper slightly less than $3\frac{1}{4}$ ins. long, and varying in width from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. Four such slips can be attached to the film of the slide with a touch of gum at each corner, they can thus be arranged to cut off the subject exactly as required. By keeping these slips true to the edges of the plate, rectangularity of the opening is secured.

Before or after binding, the slide requires spotting. Two prominent spots have to be applied for the purpose of indicating to the lanternist the correct position for inserting the slide in the lantern. These spots must be at the two top corners on the face of the slide, film side towards the operator.

There are two methods of binding a cover glass to the face of the slide so as to protect the film from injury. The first is adopted by those who make lantern slides commercially on a large scale. A strip of gummed paper about 15 in. long is moistened and attached to the four edges of the two plates, the corners being deftly mitred. The second method is to apply four separate short slips, one for each side, and it is much easier to bind a slide neatly and securely by this method. Short binding slips for attaching in this manner are obtainable, or binding slips may be made by the worker. A thin paper should be used, and gum has to be applied when ready for using. An advantage of cutting binding slips is that they may be made wider, and so hold the plates together more firmly.

LANTERN SLIDES, TWO-COLOUR TONING OF

In slides showing floral pictures, Somerville tones the leaves green by means of vanadium, and the flowers to another colour, say red or brown, which is given by the copper or sulphide toner, all the solutions being applied with a brush. A light or blocked-out background.

LANTERNOSCOPE

A viewing box for lantern slides, fitted with eyepiece or magnifying lens.

LAPIS INFERNALIS

An old name for silver nitrate (*which see*)

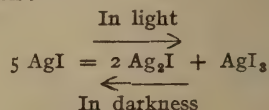
LATENT IMAGE (Fr., *Impression latente*; Ger., *Latentes Bild*)

The action of light upon many sensitive substances is at once visible by a change of colour, as in the darkening of silver or bichromate salts on paper. This is known as a direct light action. In other cases there is no visible change, and the exposed material has to be treated with some agent, usually termed the developer, which renders the action of light visible. The action of light is thus said to produce a latent image, which is of such a nature that the result of the light action cannot be quantitatively or chemically recognised.

The exact nature of the latent image has been a subject of much dispute, but the theories may be divided into two sections, the physical and the chemical. Advocates of the former consider that the action of light is to produce some change in the physical character of the silver salts, whilst the adherents to the chemical theory assume that there is an actual chemical change and the formation of a lower haloid salt, which is usually called a subhaloid.

Bearing in mind that it has been proved by Dewar that a photographic plate possesses the power of forming the latent image at temperatures closely approaching absolute zero, whilst every other known chemical action ceases at a much higher temperature, it may be asked why the photo-sensitive salts of silver should be an exception. Dr. Bose, a well-known physicist, would liken the formation of the image to the strain of the silver salt under the electric force in the light-wave, a theory known as that of molecular disturbance or strain theory. According to this, the silver bromide is converted into an allotropic form, which is more readily reduced to the metallic state than the normal silver haloid, and the function of the sensitiser is then to retard the recovery from the strain. There are undoubtedly many parallels between the strain phenomena in metallic silver and other substances under the electro-magnetic radiation of light and the effects of exposure of the photographic plate. But this theory hardly explains the various latent images which may be formed on the silver haloids, for instance with silver bromide and iodide. In the former case, so far as experience goes, the latent image is permanent, whilst with iodide there is retrogression of the image or it fades away, and the sensitive salt returns to its non-developable original state. It is stated above that the physicist looks upon the sensitiser as a substance which prevents the

recovery from the strain, and a correlative action has been found in the case of calcium oxalate for pure electric response from mechanical and light stimuli. When the action of light is permanent—that is to say, no matter how long the exposed sensitive material be kept the product of the light action, the latent image, may be developed. This is then known as an irreversible action; but if, on the other hand, the latent image reverts to its original and undevelopable condition, the action is reversible, and assuming that the formula for silver subiodide be taken as Ag_2I , then this may be expressed by the following equation:—



That is to say, in light the five molecules of AgI are split up into two molecules of subiodide, Ag_2I , and one molecule of silver triiodide, AgI_3 , whereas if such a mixture be kept in the dark, the two molecules of subiodide and one molecule of triiodide rearrange themselves and reform five molecules of silver iodide. Now as this action takes place in the presence of gelatine, but does not take place in the case of silver bromide, it seems a somewhat difficult point to explain from the point of view of the physicist.

Another physical theory is that the silver salts are charged electrically, and that the action of light is to ionise them or set free the electrons, and in support of this theory is advanced the fact that the photo-salts of silver are vigorously electric and in the order of bromide, chloride, and iodide, which is the same as their order of sensitiveness to ultra-violet light. As considerable support to this theory is also adduced the fact that eosine, fuchsine, cyanine, and other dyes set free electrons under the stimulus of light, and that the particular wave-lengths absorbed by these substances are those which are most effective in liberating the electrons. In other words, the photo-electric activity displayed is dependent upon their colour absorption, and there is thus an exact parallel with the sensitising power of these dyes for the photo salts of silver.

The chemical theories assume the decomposition of the silver bromide, and that bromine is given off; and if the formula for silver bromide be written Ag_xBr_x , in which x merely represents a given number of atoms of each element, the latent image could be described as $\text{Ag}_x\text{Br}_{x-y}$, in which y is merely a certain number of bromine. In support of this theory it must be noted that it is by no means so easy to destroy the latent image; nitric acid, potassium cyanide, ferricyanide, and acid bichromate do not entirely destroy it, and it is possible to fix an exposed plate, and yet physically develop it afterwards so as to obtain a good image.

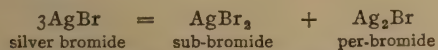
Other chemical theories are that metallic silver is produced, but this has been proved to be untenable, as strong nitric acid would dissolve silver, but does not destroy the latent image. Another chemical theory is that a subsalt is formed, but the latter forms a solid solution with the silver bromide in varying proportions.

At present, at any rate, no definite conclusion as to the nature of the latent image can be formed, and the position is probably best summed up in the words of Dr. Joly in his presidential address to the Photographic Convention in 1905: "The latent image is built up of ionised atoms, or molecules, the result of the photo-electric effect upon the illuminated silver haloid, and upon these ionised atoms the chemical effects of the developer are subsequently directed. It may be that the liberated electrons ionise molecules not directly affected, or it may be that in their liberation they disrupt complex molecules built up in the ripening of the emulsion. With the amount that we have to go upon, we cannot venture to particularise. It will be said that such an action must be in part of the nature of a chemical effect."

In connection with this subject it should be pointed out that Dr. Scheffer, of Berlin, has been able to obtain photo-micrographs of the image on silver bromide, and these prove that there is some sort of thread formation or protrusion of a filament from an exposed sensitive grain, which would certainly point to disruption of the complex; but this might agree with both the physical and chemical theories, as in the former case it would represent the disruption of the particle, and in the latter case the extrusion of the sub-bromide.

Meldola has assumed the formation of an oxyhaloid, but the objection to this is that the latent image can be formed under gases and in the presence of substances which preclude entirely free oxygen, which would be necessary for this formation.

From a series of experiments on development with the indoxyl compounds, Homolka advances the theory that the latent image is an equimolecular mixture of sub-bromide and per-bromide of silver, which is formed according to the equation:—



The existence of per-bromide has also been tentatively established by Lumière and Seyewetz, but further proof is required.

LATERAL INVERSION (See "Inversion, Lateral.")

LATITUDE OF PLATES AND PAPERS

In negative-making variations may be made in exposure, within moderate limits, without any loss of printing qualities. The latitude is, however, influenced considerably by the subject and the conditions. A subject with good contrast, or exposed in a clear and brilliant light, will allow more latitude than one deficient in contrast exposed in a dull light. With the latter and in copying, there is practically none at all.

It must be recognised that it is only in over-exposure that latitude can really exist. Loss of quality is inseparable from under-exposure. In all subjects, however, it is possible to compensate for errors in exposure to a moderate extent, if the error is known before commencing to develop. A modified solution may be applied that will have the property of compensating for

the extra exposure given. (See also "Exposure, Incorrect.")

With regard to papers, in a platinotype print there is practically no latitude; in a cold bath the development may be shortened to save an over-exposed print, but the result is distinctly inferior. An over-exposed silver print may be slightly reduced by a long immersion in the combined toning and fixing bath, but the quality suffers. A carbon print has more latitude than any other photographic printing process, as errors can be compensated when the print is partially developed: that is, the stage at which the error is discovered. Within moderately wide limits, the loss of quality is inappreciable. With bromide prints a moderate latitude could be secured by modifying the developer before commencing to develop. After development is commenced, compensation can only be made for over-exposure by shortening the duration, but this produces results that are so inferior to those produced by correct exposure and full development, that it cannot be called true compensation.

LAURUS CAMPHORA

Camphor or, more accurately, the botanical source from which camphor is obtained.

LAVENDER RAYS

A term (now practically obsolete) applied to the commencement of the ultra-violet rays just beyond the visible violet.

LAVENDER, OIL OF (See "Spike Oil.")

LEA, M. CAREY

Born at Philadelphia, 1823; died at Philadelphia, 1897. Experimentalist and writer on photographic matters, who spent much of his time in England, and did much valuable work in photography. One of his early inventions was a plate-cleaning solution, composed of potassium bichromate and sulphuric acid, often referred to as the "Carey Lea" mixture. His ferrogelatine developer (1865) consisted of a chemical combination of gelatine with the ordinary iron developer as used for the wet-plate process. He published (also in 1865) a process of intensification by means of Schlippe's salt. In 1875 he worked out a washed collodion emulsion, and in June, 1877, published the first formula for a ferrous-oxalate developer. His investigations regarding the properties of red silver chloride are of great interest to the student of colour photography.

LEAD (Fr., *Plomb*; Ger., *Blei*)

Pb. Molecular weight, 207. A bluish-grey soft metal obtained from native lead ores by roasting. It is used for making dishes and sinks owing largely to its acid-resisting properties and to its softness.

LEAD ACETATE (Fr., *Acetate de plomb*; Ger., *Bleiacetat*)

Synonyms, sugar of lead, normal plumbic acetate. Pb. $(\text{CH}_3\text{COO})_2 \cdot 3\text{H}_2\text{O}$. Molecular weight, 379. Solubilities, 1 in 2.3 water, 1 in 30 alcohol; insoluble in ether. All lead salts are poisonous, the antidotes being emetics and the use of the stomach pump, and also sodium,

potassium or magnesium sulphate, milk or white of egg. Efflorescent colourless crystals or masses with acetous odour and sweet taste obtained by dissolving lead carbonate in acetic acid. It is used in some combined toning and fixing baths.

LEAD CHROMATE (Fr., *Chromate de plomb*; Ger., *Chromsaures Blei*)

PbCrO_4 . Molecular weight, 323. Insoluble in water and alcohol. Poisonous (see "Lead Acetate"). A yellowish brown powder obtained by precipitation from a soluble lead salt and a chromate. It is used as a pigment, and also forms the colouring matter of orange fabric—a dark-room medium. A good orange safe light may easily be prepared by immersing a fixed-out dry plate for five minutes in 5 per cent. potassium chromate solution, rinsing, and then immersing in lead nitrate or acetate solution, washing and drying.

LEAD FERRICYANIDE

This is always prepared in solution by mixing lead nitrate with potassium ferricyanide, and it is used for intensifying collodion negatives.

LEAD INTENSIFIER

An intensifier used for negatives of line or black and white subjects in which no half-tones appear; it gives great contrasts and is not recommended for ordinary negatives. Immerse the well-fixed and washed negative, until thoroughly bleached, in the following:—

Potassium ferri-		
cyanide . . .	300 grs.	68 g.
Lead nitrate . .	200 "	45 "
Nitric or acetic acid	50 mins.	10 ccs.
Water . . .	10 oz.	1,000 "

Next rinse in weak nitric or acetic acid (1 in 15), wash thoroughly and blacken with ammonium sulphide, 1 part; water, 10 parts. Clear again in weak acid and wash thoroughly. The bleaching and blackening may be repeated until sufficient density is obtained, if care is taken always to wash thoroughly, as any trace of lead remaining in the negative will inevitably cause fog. Great care is also necessary when handling the film, as the acid makes the film very tender.

Other blackening agents besides the ammonium sulphide given above may be used after bleaching in the lead solution. The following have been recommended:—

(a) Water, 20 oz.; sodium sulphide, 1 oz. (b) Water, 20 oz.; Schlippe's salt, 90 grs.; ammonia, $\frac{3}{4}$ oz. (c) Water, 20 oz.; liquor ammonia, 1 oz.; potassium bichromate, 2 oz.

In process work the lead intensifier is largely used for wet collodion negatives for line reproduction. It is not so generally used for half-tone, but has been recommended in collodion emulsion work. Lead intensification has been largely superseded by the copper bromide intensifier in half-tone work; it survives for line work because of its cheapness.

LEAD NITRATE (Fr., *Azotate de plomb*; Ger., *Bleinitrat*)

$\text{Pb}(\text{NO}_3)_2$. Molecular weight, 331. Solubilities, 1 in 1.85 water; almost insoluble in alcohol.

White translucent crystals prepared by the action of nitric acid on lead or lead carbonate. Poisonous (see "Lead Acetate"). It is used in the lead intensifier and in the combined toning and fixing bath.

LEAD, SUGAR OF (See "Lead Acetate.")

LEAD TONING

Albumen and gelatino-chloride prints may be toned with lead acetate. The colouring is due to sulphuration and the results are not permanent. A simple formula is:—

Lead acetate . . .	$\frac{1}{2}$ oz.	27.5 g.
Sodium hyposulphite . .	4 "	220 "
Water . . .	20 "	1,000 ccs.

The above is a "combined" toner and fixer as well. The tone obtained is due to the formation of lead sulphide. There are many other formulae.

Messrs. Lumière have found that by employing salts of lead made from di-, tri-, tetra- and penta-thionic acids, mixed with a solution of "hypo," a toning and fixing compound can be obtained, which, without gold, gives warm tones, and with gold colder tones.

Lead acetate is often used in conjunction with gold in many of the combined toning and fixing baths. The following is typical:—

Sodium hyposulphite . .	5 oz.	275 g.
Citric acid . . .	60 grs.	7 "
Lead acetate . . .	60 "	7 "
Ammonium sulpho-		
cyanide . . .	200 "	23 "
Gold chloride . . .	3 "	35 "
Water . . .	20 oz.	1,000 ccs.

Dissolve all but the gold chloride in the order named in hot water, boil, filter, and then add the gold chloride.

LEATHER, PHOTOGRAPHS UPON

White leather was used by Wedgwood, Reade, and others in the early days of photography as a support for the sensitive silver salts. In the wet plate days collodion positives were sometimes made on black patent leather, the image appearing, of course, of a white or cream colour, like a modern ferrotype picture. Modern photographs upon leather are usually produced by the carbon transfer process, or by sensitising the leather with a suitable bromide or other emulsion.

Unless special precautions are taken emulsions will soon decompose when ordinary leather is prepared direct with a sensitive emulsion; in the same way the gold of toning baths decomposes, and the prints soon become spotty because of the chemical action of substances contained in the leather. To overcome this, it has been recommended that the leather be given a substratum of collodion of $\frac{1}{2}$ to 1 per cent. strength. After twenty-four hours the leather may be coated with any sensitive emulsion and then treated in the same way as plates and papers.

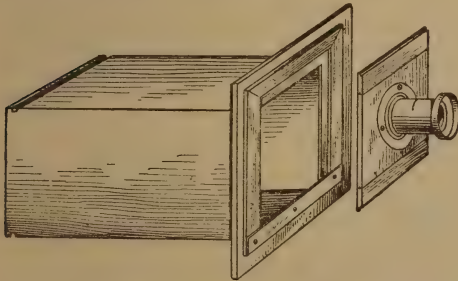
LEIMTYPE

A process commonly associated with the name of J. Husnik, of Prague, who took out a

patent in 1887, but a very similar process was patented in Boston, U.S.A., in 1871, by W. H. Mummler. The object is to obtain images in high relief for direct typographic printing. A thick layer of bichromatised gelatine is exposed under a line negative, next attached by means of guttapercha to zinc or wood, and then developed with a solvent such as a saturated solution of an alkaline bichromate. This not only dissolves those parts acted on by light, but also strengthens the relief parts. After development, the plate is dried, and the hollow parts are filled with an opaque printer's ink by means of a camel-hair brush. The plate is then exposed for a second time to the action of light, by which it is hardened and strengthened in the lines.

LENGTHENING CAMERA

For copying, and in photographing small objects at close quarters, the bellows extension of an ordinary camera sometimes proves insufficient. The professional photographer in such a case makes use of a wooden tube or cone, fitting on the front of the camera and carrying the lens at the outer end, as illustrated. But



Wooden Extension to Camera

a good modern studio camera will usually have an extension adequate for any probable requirements. For smaller cameras, extension accessories of various kinds are obtainable, some being made to fit the front and others the back of the camera. (See also "Extension, Camera.")

LENS (Fr., *Lentille*, *Loupe*, *Objectif*; Ger., *Objectiv*, *Linse*)

Photographically, a lens is a combination of two or more glasses capable of producing an



A. Landscape Lens



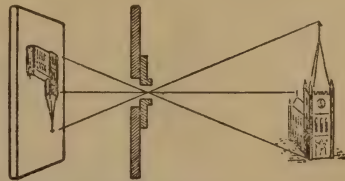
B. Zeiss Rapid Anastigmat Combination



C. Chevalier's Achromatic Meniscus

image. Simple or "spectacle" lenses, consisting of one piece of glass, are occasionally used to obtain special effects, but the single achromatic combination may be taken as the starting point in the evolution of the modern

photographic objective. The elementary forms of lenses, as illustrated under the headings "Concave Lens" and "Convex Lens," made in a great variety of glasses and with widely differing curves, are used in combination to

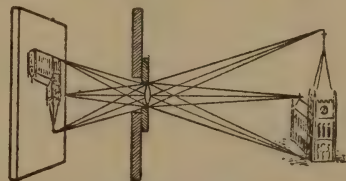


D. Principle of the Pinhole

build up the more or less complex objectives now in use. The simplest combination of these elements is found in the single "landscape lens" A, which is composed of a double convex lens of crown glass cemented to a plano-concave of flint glass, thus securing achromatism (see "Chromatic Aberration"); while the latest and most complex combination is found in the Zeiss anastigmat B, composed of four elements cemented together, two of such combinations forming the "Series VIIa Rapid Anastigmat." It will be convenient to deal with the principal types of lenses in groups, showing their gradual development, as improvements in the various forms have been and are proceeding simultaneously.

The action of a photographic lens may be better understood by considering what happens when a small bevelled opening is made in the shutter of a darkened room, as at D. Rays of light from all parts of any object outside—say, a church—are admitted by the aperture, cross each other, and proceed in straight lines to form an inverted image on the wall opposite. Photographs can, in fact, be made with a pinhole instead of a lens. Except with a very small opening, however, which means a long exposure, the image is blurred. By using a convex lens, as at E, which has the property of converging light rays and bringing them to a focus, a much larger aperture becomes possible, together with improved definition.

Single or Landscape Lenses.—In its primitive form, the single combination was nothing more



E. Principle of the Lens

than the object lens of a field glass. The first lens made specially for photography was of this model, and was issued by Chevalier, of Paris. This maker soon issued an improved model, now generally known as an achromatic meniscus C, which had a much wider field of definition and greater rapidity than its

predecessor. This was followed by Grubb's aplanatic F which departed from the telescope lens construction, being composed of two meniscus elements; in this lens the relative positions of the crown and flint glasses were reversed, greater covering power and rapidity being thus

concave flint. Both these early forms of portrait lenses were comparatively slow in action, and were superseded by the Petzval portrait lens K (introduced by Voigtländer in 1840), which, with little modification, is the standard lens for studio work at the present day. It gives greater



F. Grubb's
Aplanatic
Lens



G. J. H. Dallmeyer's Wide-
angle Lens



H. T. R. Dallmeyer's Rapid
Landscape
Lens



K. Petzval Portrait
Lens



L. J. H. Dallmeyer's
Portrait Lens

obtained as well as portability. The next forward step was made when J. H. Dallmeyer constructed a wide-angle landscape lens of three elements (see G), a concave flint being between two crown meniscus glasses. This covered the widest angle ever attained by any single lens, the longest side of the plate being equal to the focal length of the lens, while the curvilinear distortion was reduced to a minimum. By the use of different glasses, T. R. Dallmeyer constructed a lens on the same lines, covering a narrower angle, but working at the large aperture of $f/10$. This was known as the Rapid Landscape lens (see H) and was recommended for distant views, large heads, and subjects where pleasing perspective was preferable to wideness of angle. Still later, the same optician produced a non-distorting "single" lens, the "Rectilinear Landscape" I, which, although fitted with an outside diaphragm, was absolutely rectilinear. Its comparatively small aperture ($f/14$) prevented its general adoption, the rapid rectilinear with an intensity of $f/8$ being preferred. There is an internal air-space in this lens. A somewhat similar lens was produced by J. T. Goddard, but did not appear on the market.

Portrait Lenses.—At a very early period in the practice of the art the necessity for a rapid

flatness of field, and the presence of an air space between the flint and crown elements of the back combination, gives perfect correction for spherical aberration. The only important modification in the design of the portrait lens was patented by J. H. Dallmeyer in 1886, improved covering power being obtained together with less liability to flare. This lens is shown in diagram L. In the Dallmeyer lens the position of the crown and flint elements is reversed, the crown element being a meniscus instead of a "crossed" double convex lens. These lenses are fitted in an adjustable cell so that the distance between them can be varied at will; when placed closely together, sharp definition is obtained, while by separating them more or less "softness" results. The front combination of both types of portrait lens is frequently used alone, either for landscapes or for portraits, especially large heads. Small lenses of this form were used for rapid landscape work in the earlier days of the art, but at the present time they are rarely used except by naturalists and for night photography.

Doublet Lenses.—The want of rapidity and rectilinearity of the single lens and the bulk and cost of the portrait lens, caused attention to be directed to the production of lenses for copying, outdoor work, etc., which should be free from these defects. One of the earliest of these was the Orthoscope or Orthographic lens of Petzval



I. T. R. Dallmeyer's
Rectilinear Land-
scape Lens



J. Ross (Collen)
Portrait Lens



M. Ross Doublet



N. Rapid Recti-
linear Lens

lens was felt by portrait photographers; and in 1841, Andrew Ross constructed a double combination lens J for Henry Collen. This consisted of two cemented combinations, one being placed at each end of a tube to which central diaphragms were fitted. In the same year Thomas Davidson produced a symmetrical lens for portraiture, this being composed of two similar combinations, each composed of a plano-convex crown cemented to a plano-

(made by Voigtländer in 1859). For this lens great claims as to flatness of field, rectilinearity and other virtues were made, although actually it possessed but little advantage over the single landscape lens. It had a greater equivalent focal length than the distance between any part of the lens and the focusing screen, or, in other words, it was to a certain extent a telephoto lens, the back combination being of the negative form. The orthoscope was succeeded, in 1864, by several doublets of various rapidities, but all

somewhat similar in type, designed by Thomas Ross (*see* M), and these enjoyed considerable popularity for many years, some being still in use. The next great stride towards perfecting the photographic lens was made in 1866 when Dallmeyer, in London, and Steinheil, in Munich, almost simultaneously issued lenses of the type which is so well known under the name of Rapid Rectilinear (*see* N), the original uncorrected form of Steinheil being designed for wide-angle work only. This lens, working at an intensity of $f/8$ or more, gave perfectly rectilinear images, having a fairly flat field and being free from flare or "ghost," and achieved immediate success. Lenses on similar lines, but slower in action, were constructed for wide-angle work, and no considerable improvement was made until the Zeiss and Goerz anastigmats appeared on the field in the early nineties of the nineteenth century. Rectilinear lenses were made by J. H. Dallmeyer with an intensity as high as $f/3$, while other forms, known as the "euryscope," "extra rapid rectilinears" or "universal symmetrical" had intensities of about $f/6$. The wide-angle rectilinears or portable symmetricals usually had a maximum aperture of $f/16$. An "actinic doublet" was achromatised for actinic effect; but modern doublets are achromatised for both the visual and actinic effects.

Anastigmatic Lenses.—Lenses of greatly improved design were introduced in 1890 by Carl Zeiss, of Jena, the first model being an apochromatic triplet, this being followed by a double combination which was greatly superior to all lenses then existing. Improvements have followed in rapid succession. The Series VII (*see* B) may be considered as being the most useful type of the Zeiss anastigmats, being truly universal in its character. The single lenses are perfectly corrected for astigmatism, spherical aberration and curvature of field, and are practically rectilinear. Their intensity is $f/12.5$. Used in combination to form doublets they retain all their good qualities with the addition of greatly increased covering power, angles of 80° to 90° being obtained, while the intensity varies from $f/6.3$ to $f/8$, according to whether lenses of similar or dissimilar focal lengths are combined. In 1893 an excellent series of double anastigmats was introduced by Goerz with an intensity of $f/7.7$ afterwards increased to $f/6.8$. Each combination is composed of three glasses cemented together. The single combinations may be used for landscapes, but do not work at the same large aperture as the Zeiss lenses. The Goerz "Pantar" lens, recently introduced, corresponds in rapidity to the Zeiss Series VIIa. Other opticians have placed on the market lenses corresponding to the Goerz model under various names.

The foregoing may be considered as the principal groups of lens types, but many other forms are described under separate headings.

In process work, it is essential that the lens should give perfect definition uniformly all over the plate, that it should be free from distortion and astigmatism, and give even illumination; and that it should be colour-corrected. For line reproduction it is not necessary to work with a large aperture, and therefore by stopping down extreme sharpness is obtained. In half

tone large apertures are not permissible on account of the action of the ruled screen. For the same reason the focus must not be too short; an equivalent focus of about 18 inches is usually considered best for a 15-inch by 12-inch plate. In colour reproduction without the ruled screen interposed large apertures are desirable to counteract the considerable lengthening of exposure due to the action of the colour filters. Process lenses have to be fitted with Waterhouse diaphragm slot in order to permit of variously shaped stops being used.

LENS ADAPTERS

Threaded brass rings which enable a lens to be screwed into other flanges than those for which it was originally screwed. In cases where the screw-threads on the lens and flange do not agree, and in the absence of an adapter, it is necessary to have for each lens a detachable front (*which see*).

LENS, POSITION OF STOPS IN

With the majority of lenses the position of the stop or diaphragm is determined by the maker, and in many modern lenses there is only just sufficient room to allow the iris to be fitted. In the case of a compound lens having front and back components of equal focal length, the diaphragm should be placed equally distant from each, but in the case of components of unequal focal length the diaphragm should be placed at a distance proportionate to the focal length from each lens—that is to say, a little nearer to the lens of shorter focal length—otherwise, the combination will not give rectilinear images. The diaphragms of single lenses are usually placed at a distance equal to the diameter of the lens, but this distance may be varied at discretion, a flatter field with a reduced circle of illumination being obtained when the diaphragm is placed farther from the lens. Flare spot is often due to an incorrect position of the diaphragm. Portrait lenses usually have the diaphragm midway between the glasses; but for outdoor work, the tendency to flare is greatly reduced by placing the diaphragm slightly in front of the lens, this somewhat reducing the size of the field covered.

LENSES, BRASSWORK OF

The term "brasswork" is applied generally to the metal cell which holds in place the various glasses of which a modern lens is composed, although both aluminium and brass are used for the purpose. The production of the brasswork demands the application of highly-trained skill and the use of machines which work with scientific precision. The screw threading must be efficient, and it is a matter for regret that all lenses are not threaded uniformly to one system. The Royal Photographic Society has recommended certain measurements and standards, which will be found under the heading "Mounts, Lens." It is necessary that the inside surfaces of the brasswork should be blackened to avoid producing cross reflections, which would seriously interfere with the efficiency of the lens. (For a method of blackening camera brasswork, *see* "Blackening Apparatus.")

LENSES, CEMENTING AND UNCEMENTING

Lens glasses are cemented together with Canada balsam, which needs to be specially prepared for the purpose. The balsam as bought should be put in a saucer and baked in an oven until, when cold, it will be hard. The hard balsam needs to be broken up, placed in a bottle and covered with benzene, allowed to stand for about twenty-four hours, and then gently heated over a water-bath until fluid. The lens glasses, having been cleaned with extreme care, should be gently warmed, and a drop of the warm balsam placed in the centre of the concave glass. Next the convex glass is pressed down into the concavity until the balsam has spread and oozed out at the edges. The lens is left for the balsam to harden, or this process may be hastened by gently heating in an oven of which the door is open. At the end of a few days any surplus balsam on the edges may be removed with a rag moistened with benzene.

A safe method of uncementing a lens is to place it (minus its mount) in a glass vessel, and to pour warm water upon it; the water is kept warm, by means of a spirit lamp or Bunsen burner, until the glasses can be slid apart. Should this fail, soak in turpentine.

LENSES, CLASSIFICATION OF

In the past, when photographic lenses were more limited in their capabilities, it was usual to designate them according to the class of work for which they were best adapted. Thus there were view lenses which were not adapted for architecture; portrait lenses of great rapidity but limited covering power; group lenses which were usually portrait lenses of a slower variety; copying lenses which were rectilinear but still slower in action, etc., etc. Under modern conditions the necessity for such classification has almost disappeared, as a good anastigmat will answer for practically any class of work, subject only to the angle which it is capable of embracing. Lenses for copying still form a class by themselves, as slight modifications in design are necessary to obtain the best possible covering power when the back and front conjugate foci are equal or nearly so.

LENSES, CLEANING

Careless cleaning must always be guarded against, and such a thing as vigorous rubbing with a harsh duster most strictly avoided. The proper methods of cleaning lenses are explained under the heading "Cleaning Lenses."

LENSES, CONDENSATION ON

In a damp atmosphere, moisture rapidly condenses upon a lens which is colder than the atmosphere itself. The trouble is especially likely to occur in early morning and towards evening, and in photographing in certain kinds of factories, underground workings, and at great heights where the atmosphere is highly charged with moisture. It is not a bad plan to carry the lens, enclosed in a wash-leather or other case; in a pocket of one's clothes to ensure its temperature being higher than that of the atmosphere. But in addition to this precaution,

which may not always answer, it is necessary to watch for the condensation and, should it form, to remove it at once. The presence of condensed moisture on a lens makes photography hopeless.

The lanternist has especially to guard against moisture condensing upon either objective or condenser; and he should make it a rule to examine the lenses immediately before beginning an exhibition. A lantern brought from the cold street straight into a hall where people are congregated is sure to need attention.

LENTICULAR STEREOSCOPE (See "Stereoscope.")

LERMANTOFF'S STEREOSCOPE (See "Stereoscope.")

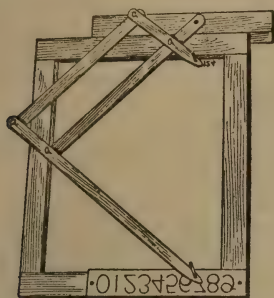
LETTERING NEGATIVES AND PRINTS

The advantage of lettering a negative rather than a print is that the work requires to be done but once, and then any number of prints can be made, each with the lettering printed upon it. The usual way of writing on a negative to produce white letters on the print is to write the title backwards on the film side with opaque pigment, such as red water-colour or Indian ink, applied with a finely pointed camel-hair pencil, in this way obtaining effective titles upon the shadow (clear) portions of the negative. The backward writing needs some little practice, and it may be found helpful to write the title properly upon the glass side, and then to follow the outline of the letters on the film side; while another plan is to write the title properly upon a piece of glass, lay the titled glass, inscription side downwards, upon white paper and use as a guide for the eye. Many methods of transferring the title to the film have been recommended; a good one is to write the title properly upon white paper with a fine pen and an ink made by dissolving either methyl-violet or eosine in water. When the ink is dry, the paper and the wet or damp film are brought into contact by pressing with the finger; the paper is then pulled away and the reversed lettering will be found on the film; it may easily be strengthened if necessary. A copying-ink pencil has been recommended in place of the dyes.

A transfer paper can be made by coating smooth paper with a thin solution of rubber in benzol, allowing to dry, coating with a thin solution of gelatine, and again drying. The title is written upon the gelatine surface with waterproof ink, and is transferred by trimming the paper to the proper size, and soaking it for a minute in cold water. It is then pressed on the film side of the negative, the superfluous water being removed with clean blotting-paper. The transfer paper is allowed to dry upon the negative, and is then moistened at the back with benzol, which dissolves the film of rubber, enabling the paper to be stripped off, leaving the thin gelatine film with the title beneath it upon the negative. Another method is to write the title upon a thin film of celluloid or tracing paper, and to stick it face downwards upon the film with a transparent adhesive.

To letter a negative so as to produce a black title upon the print, it does not suffice to scratch

the film with a sharp point, as this causes ragged lines; it is better to use a bleaching solution made by adding equal quantities of glycerine and liquid gum to tincture of iodine; the fluid should flow evenly from a quill pen. The title



Numbering Negatives with the Pantograph

is written in the reverse way with this solution, which must be used with care and not allowed to spread. Immediately the lettering appears white right through the gelatine, wash the negative quickly in water to stop the bleaching action and immerse in a "hypo" fixing bath, which dissolves out the bleached letters and leaves clear glass; finally, wash and dry.

Numbering is not so difficult as lettering, and is, of course, done in the same way. The illustration shows how the well-known pantograph can be applied to the work. In a frame the negative is laid film upwards. At the lower end is placed a strip of metal on which is engraved a set of numerals reversed. The lower end of the pantograph is made to follow the outline of the desired numeral, this being reproduced on a small scale at the upper end by a pencil, stylus, or needle-point.

The following method may be adopted where the titles are required in neat type characters: Set up the titles in type and get a good proof on enamel paper. Photograph this impression, using a wet plate for preference. Then from this negative make a transparency. When this is dry, strip the film and attach it to the negative with an adhesive. This will give white lettering on dark ground. Black lettering on a light ground can be obtained by printing from a separate negative on to the paper or plate, using register marks to ensure exact position.

Titles on prints may be written in waterproof ink, black or white, each print being done separately, of course. The sensitive paper may be written on before printing, using Indian ink, red water-colour, etc., which, when toning and fixing, becomes washed away, leaving white lines. Finished prints may be written upon with the following chemical ink:—

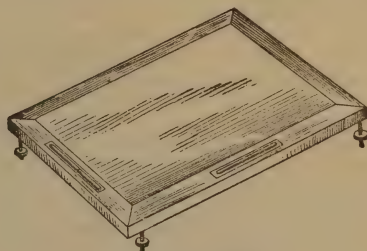
Potassium iodide	. 170 grs.	40 g.
Iodine	. 17 "	4 "
Gum arabic	. 17 "	4 "
Distilled water	. 1 oz.	1,000 ccs.

This written upon the dark part of a silver print discharges the colour and appears white. Or, if preferred, a white pigment ink may be used. Black letters upon finished prints are made with black waterproof ink or by letterpress printing.

LEVEL, CAMERA (See "Camera Level.")

LEVELLING SLAB (Fr., *Dalle à niveler*; Ger., *Nivellierplatte*)

A flat, smooth plate of glass, slate, marble, or other material, either attached to a framework that may be levelled accurately by means

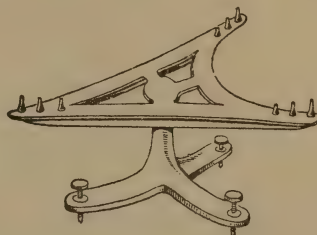


Levelling Slab

of screws at the corners, as illustrated, or intended for use on a levelling tripod (*which see*). Employed as a support for plates to be coated with emulsion, or for other purposes where a perfectly even distribution is indispensable.

LEVELLING TRIPOD (Fr., *Support à niveler*; Ger., *Nivelliergestell*)

A stand in the shape of a tripod, with screws at the feet for accurate levelling, as illustrated. It may be either large enough to support a



Levelling Tripod

levelling slab (*which see*), or sufficiently small to hold single plates, and is used to ensure a film of even thickness when coating plates with emulsions, etc.

LICHTDRUCK (Ger.)

An early name for the collotype process (*which see*).

LICHTKUPFERDRUCK

A photogravure process invented by J. B. Obernetter, of Munich, about 1886. From the original a negative was made and converted into a silver chloride positive, which was then placed in contact with a perfectly flat copper plate. The quantity of silver chloride thus deposited on the metal corresponds exactly to the intensities of the original; thus, in the darker parts there is a denser, and in the lighter parts a less deposit. By a simple galvanic process, the silver chloride is decomposed and is replaced by a soluble chloride and metallic silver.

The copper is by this means etched out, the depths corresponding to the amount of silver chloride in the different tones. The hollows of the plate are filled with ink for printing in the usual copper-plate manner.

LIGHT (Fr., *Lumière*; Ger., *Licht*)

Light is generally considered to be due to minute undulatory waves in the ether that pervades all space. The molecules of any luminous body are in a state of rapid vibration, this movement being communicated to the adjacent ether particles and transmitted by a wave-like motion to the eye, the impact of the waves on the retina giving the sensation of light. In free space light moves with the velocity of 186,000 miles per second. It travels invariably in a straight line, in a medium of uniform density. Light falling on a mirror or other polished surface is either wholly or partially reflected, at an angle equal to that at which it strikes the reflecting surface. (See "Reflection.") White light is not homogeneous, but a mixture of various colours, of different wavelengths. The colours of objects in Nature are not inherent in themselves, but due simply to their absorbing certain rays and transmitting others. (See "Colour.") If a beam of light is caused to pass through a small opening or slit and to fall upon a prism, it is separated into its constituent colours. (See "Dispersion.") Besides the visible rays of the spectrum so obtained there are others that are invisible. Those beyond the violet end of the spectrum are known as the ultra-violet rays, and are of great actinic power; at the opposite end are the infra-red rays. If a prismatic spectrum is thrown on a sheet of white paper in a darkened room, and the region beyond the violet is painted with a solution of quinine sulphate, it will at once be illuminated with a violet light. It is thus seen that certain substances have the power of reflecting or emitting rays quite different from any that are originally thrown upon them. (See "Fluorescence.") When a ray of light passes obliquely from one transparent medium into another of different density it is bent aside from its course. (See "Refraction.") If light falls at an angle on a very thin film or plate it is partly reflected at the first surface, while part passes through, undergoes refraction, and is reflected back from the second surface in a direction parallel to the portion first reflected. The two sets of light waves will interfere with each other at certain points, in such a manner that the waves appertaining to one or more of the colours will be extinguished, so that the reflected light appears of a colour complementary to the missing rays. The particular rays extinguished will vary according to the obliquity of the incident ray and the thickness of the film or plate, so that if the film is of varying thickness a number of colours will be seen. It is in this way that the play of colour in a soap-bubble is caused, as also the phenomenon known as Newton's rings, which is turned to account in testing the figuring of lenses. (See "Interference of Light.") When light from a bright point or slit passes through a minute aperture it emerges as a series of coloured bands; the same effect occurs when light is

reflected from a surface covered with a number of very fine indentations or scratches. (See "Diffraction.") Certain crystals, such as Iceland spar, have the property of dividing a ray of light into two distinct refracted parts, one obeying the ordinary law of refraction, while the other has a peculiar law of its own. (See "Polarisation.") Many substances continue to give out light in darkness after removal from the exciting source of light, a phenomenon known as phosphorescence (*which see*). (See also "Absorption" and "Spectrum.")

LIGHT, ABSORPTION AND REFLECTION OF

Absorption is dealt with under its own heading; but, in one sense, it may be regarded as involving the obstruction of light. Thus, for example, a glass window absorbs the light falling upon it in the following percentages:—

Plain glass, clean	7 to 10 per cent.
Plain glass, dirty	40 per cent. and upwards
Ribbed glass	15 to 30 per cent.
Opaline glass	15 „ 40 „
Ground glass	30 „ 60 „

The following table gives the percentage of light reflected by various mediums. In nearly all cases the figures are merely approximate:—

	per cent.
Mirror	95
White blotting-paper	82
White cartridge paper	80
Ordinary foolscap	70
Newspapers	50 to 70
Planed deal (clean)	40 to 50
Yellow wall paper (clean)	40
White tracing cloth	35
Blue paper	25
Planed deal (dirty)	20
Yellow wall paper (dirty)	20
Brown paper	13
Macadam road	8
Chocolate paper	4
Black surface	1

To obtain the same density for the various colours on an ordinary plate as that given by white or blue light, the following approximately relative exposures must be given:—

Violet	2
Green	4
Greenish-yellow	30
Yellow	36
Orange	120
Red	1,600

LIGHT, CONTINUING ACTION OF (See "Continuing Action of Light.")

LIGHT, DIFFRACTION OF (See "Diffraction.")

LIGHT FILTER (See "Colour Screen or Filter.")

LIGHT FOG (See "Fog.")

LIGHT INTENSITIES, DIFFERENCE IN

Daylight varies in intensity according to the time of day and year, and also according to the



PORTRAIT

BY H. ESSENHIGH CORKE, F.R.P.S.

A photograph in natural colours, taken on the Thames plate, and reproduced by the four-colour process.

latitude. Further, the freedom or otherwise of the sky from clouds has an important influence. As the exposure of a sensitive plate is dependent on the intensity of light, it is important that this should be determined, and numerous tables have been published giving the variations, but of recent years the plan of actually testing the actinic power of the light by exposure meters has come into general use, thus doing away with the personal equation in the estimation as to whether the light is "bright," etc.

LIGHT RAYS, COLOURS OF

Every ray of the spectrum has its own particular colour, although the human eye is not sufficiently sensitive to differentiate between rays that are closely contiguous. (See "Spectrum.")

LIGHT, REFRACTION OF (See "Refraction.")

LIGHT STANDARDS (Fr., *Étalons de la lumière*; Ger., *Licht-einheiten*)

Various units have at different times been adopted or recommended for comparing light intensities, such as the standard sperm candle, the amyl-acetate lamp, the Carcel lamp, the Methven screen, the pentane lamp, etc. These are dealt with under their respective headings. Acetylene has also been suggested for use. The British unit, the sperm candle (1 c.p.), is subject to slight variations from different causes, and scientific workers now commonly prefer to use the pentane lamp. The Methven screen and the pentane lamp are each equal to 1 c.p. and are equivalent to 1.14 Hefner-Kerze, or "H. F." (amyl-acetate lamp); while the Carcel lamp gives a light equal to about 9.5 standard candles. (See also "Sensitometry" and "Unit of Light.")

LIGHT, UNIT OF (See "Unit of Light.")

LIGHTING OF LANDSCAPES

An astonishing variety of effects may be obtained from the same landscape, due entirely to differences in its lighting. Some views are most effective as seen under a soft grey light, whereas in other cases a strong lighting gives the best result. In a bright light the most unsatisfactory position for securing the view is with the light directly behind the camera, and, therefore, full on the subject, as the shadows are concealed by the objects casting them. A side lighting is far more satisfactory as giving more relief and allowing the shadows to play their part in the arrangement of the picture. It is often possible to secure a striking and pleasing effect by photographing "against the light"—that is, with the sun more or less opposite the camera—but it is necessary to protect the lens from the direct rays of light. Another opportunity for variation in effects comes when there are clouds through which the sun breaks at intervals in such a manner as to light up this or that portion of the view, while the rest remains in shadow. Such a play of light and shade on a landscape must be accounted for in the print by a sky that corresponds; so that, if it is not possible to record the sky on the same plate as the land-

scape, a second plate should immediately be used to secure the sky with a shorter exposure. Not only are the amount and the direction of the light important considerations in landscape work, but also the condition of the atmosphere. A certain amount of haze or mist veiling the distance is often of the greatest value in the pictorial effectiveness of the result. There is much educative value in taking a series of views of the same landscape under as many different conditions of lighting as possible and carefully studying the results.

LIGHTING OF SITTERS (See "Portrait-ure," and other headings.)

LIGHTNING, PHOTOGRAPHING

The first successful photograph of a lightning flash was taken on a dry plate on September 2, 1882. Lightning cannot be photographed during the daytime, as, however dark the sky is, the sun is behind it and actinic enough to have an action upon the dry plate, and make the flash invisible. At night the sky may be black and have no action upon the photographic plate, the flash appearing to stand out prominently. It is not advisable to photograph lightning through a closed window. Coming storms exhibit the best flashes, although at the seaside good flashes may often be obtained from storms disappearing seawards. The finest lightning photographs have been taken looking seawards, there being no obstructions between camera and horizon. The latter should always be included in the picture, as when taking clouds; otherwise, in the photographs, it may not be easy to tell the top from the bottom of the flash. The camera must be supported, either by a stand or other means; if it is of fixed focus, there will, of course, be no focusing necessary, but if of the focusing pattern, the lens should be racked out to the position it would occupy if a distant view were being photographed. It is desirable to focus during the day and to make a mark on the baseboard, so that the focus may be instantly ascertained at night, when accurate focusing is impossible. Having made all ready and fixed the camera with the lens pointing in the direction of the flashes, the dark-slide is inserted, the shutter drawn, the plate exposed, and the flash waited for; when it does appear, providing that it is within the range of the lens, it photographs itself; the lens is then capped and the plate changed. It is advisable to use wide-angle lenses so as to include as much of the sky as possible, as forked lightning has a way of disappearing from a narrow field of view. The largest possible stop should be used, and a rapid plate, well backed so as to prevent halation. Detail is not so much wanted as contrast in the negative, and development should therefore not be continued long enough to produce fog, as a flash showing but faintly on a negative may easily be intensified, preferably with mercury and ammonia. One developer is as good as another for negatives of this class, but hydroquinone and a mixture of hydroquinone and metol appear to be the favourites. The plate should be changed after every flash photographed, no matter of what kind; one may be unfortunate enough to expose a dozen or more plates on weak

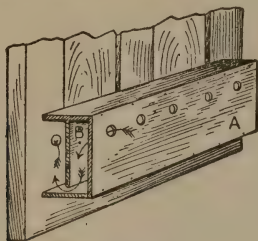
sheet flashes, which are useless photographically, while, on the other hand, one may be fortunate in securing a forked flash every time. Sheet lightning will fog a plate and make it quite useless.

LIGHT-STRUCK

A term applied to sensitive plates or papers that have been fogged by exposure to actinic light. The term is sometimes applied to dark foggy streaks upon the negative caused by the dark-slide not being perfectly light-tight. (See also "Fogged Dry Plates, Restoring.")

LIGHT-TRAP FOR DARK-ROOMS (Fr., *Trappe-lumière*; Ger., *Lichtfalle*)

A ventilator admitting air to the dark-room while excluding light. A common form is that illustrated. A row of holes is bored at the bottom or top of the door, or in any other suitable place, and a three-sided case of wood A



Light-trap

is made having a similar series of holes. In the middle of the case is a partition B reaching nearly across. The case, blackened inside, is attached to the door by screws or angle-pieces and the two ends are boxed-in. Since light can only travel in a straight line it is effectually blocked, whereas the air proceeds uninterruptedly into the room, as shown by the arrows. It is usually necessary to have at least two light-traps, one at the bottom to admit fresh air and another at the top for the exit of foul air. (See also "Dark-room Ventilation.")

LIGNIN (Fr. and Ger., *Lignin*)

Woody fibre. Formed from the cellulose of plants by incrustation with other compounds, probably aromatic, during the change into wood. It was at one time believed to be identical with cellulose ($C_6H_{10}O_5$) in chemical composition, but later research has shown that this is not so, the true formula being approximately $C_{12}H_{18}O_6$. It is decomposed by sulphuric acid, forming dextrine.

LIME, CARBONATE OF (See "Calcium Carbonate.")

LIME, CHLORIDE OF (See "Calcium Hypochlorite.")

LIME, CHLORINATED (See "Calcium Hypochlorite.")

LIME IN WATER

The presence of lime in the washing water sometimes causes a scum to appear on the dried

negative; and although the deposit is of but little importance in itself, it may interfere more or less with the proper working of an intensifier or reducer. Lime scum appears mostly when the ferrous oxalate developer is used, and is due to precipitation of lime oxalate. It may be removed by placing the negative before drying in a weak solution of hydrochloric acid (4 drops of acid to 1 oz. of water). Some workers use alum water, as it dissolves the lime without softening the gelatine. When the presence of lime is suspected, the negative should be wiped with a pad of wet cotton-wool before drying.

Water may be tested for lime by adding to it a solution of ammonium (or potassium) oxalate; a milkiness or white precipitate indicates the presence of a calcium salt.

LIME WATER

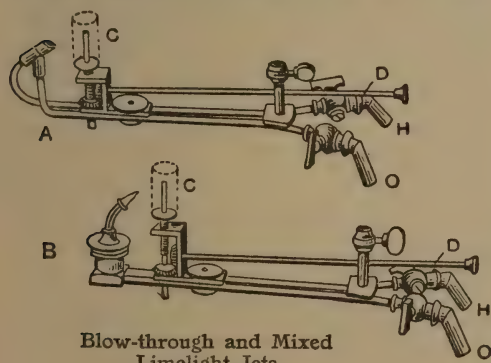
Known also as *liquor calcis*, and prepared by shaking up pure slacked lime in distilled water and decanting. Commercial lime water contains half a grain of calcium oxide (quicklime, CaO) per ounce.

LIMELIGHT

An illuminant for use in optical lanterns, etc., in which a spot on the surface of a cylinder of lime is heated to incandescence by a gas flame fed with oxygen under pressure. Oxyhydrogen limelight has a photometric value of 16.6, as compared with that of a multiple-wick lamp 1, and of a 50-ampere arc lamp 160. When an ordinary flame, as of hydrogen, coal-gas, alcohol, etc., plays upon a piece of lime, the latter becomes dull red-hot, but when the combustion is forced and made more complete by means of a supply of oxygen under pressure, the heat of the flame is increased to such an extent that a small part is raised to such a high temperature that it emits a blinding white light. In the past, the combustible gas for limelight has been supplied in a number of different ways. The best known of these, hydrogen, was made by acting with dilute sulphuric acid on scrap zinc; the gas was stored in a collapsible bag which, when required, was connected to the limelight jet. By other systems, special forms of jets were necessary; for example, in one was a simple spirit lamp through the flame of which a jet of oxygen was forced; in another was a vessel containing ether, through which was passed a current of oxygen, which thereby became laden or saturated with particles of the ether and was then burnt at a nipple. All such arrangements are, or should be, obsolete, as by the modern system of supplying gases in steel cylinders (see "Compressed Gas") a convenient and safe supply of a combustible gas is easily secured. These cylinders are periodically tested and annealed, and their use is attended by a minimum of risk, which is not the case in the oxy-alcohol and oxy-ether systems, especially the latter.

Limelight jets are of two main kinds—the blow-through and the mixed. In the former, A, the gases do not mingle until they reach the point of combustion; in the latter, B, the gases mingle in a mixing chamber at the base of the actual jet. The more intimately the gases mingle, the greater is the heat of the flame

produced, and therefore the high-power jet is always of the mixed type, the blow-through jet being practically restricted to the use of the beginner. The jet is supported on a vertical pin projecting from a sheet-metal tray which slides into the lantern body from the back. One nozzle H is connected by rubber tubing to the hydrogen supply, which in the case of a mixed jet is a cylinder, and in the case of a blow-through jet is a cylinder or an ordinary gas bracket. The other nozzle O is connected to the oxygen supply, which, nowadays, is always a cylinder. In the case of the blow-through jet, the nozzles are connected to the gas supplies in such a way that the oxygen issues in a stream from the central nipple, whilst the cone of burning hydrogen surrounds it. The taps are generally stamped with either "O" or "H," indicating the proper connections. The lime cylinder (see dotted lines c) is supported on a pin at an adjustable distance from the nipple, there being provision for rotating the lime by means of the rod D, so as



to obviate the formation of deep pits in the lime while the jet is in use. When a flame plays upon a deeply-pitted lime, there is a risk of the lime cracking or of the flame being deflected upon the condenser. The distance of the lime from the nipple is a matter for experiment and varies with the class of jet; it has a great influence upon the quality of the light. Simple jets are here illustrated, but very elaborate appliances are obtainable, these being fitted with screw-down adjustment valves and various mechanical devices for regulating the light as regards its height, distance from condenser, distance of lime from nipple, etc.

The following matters should receive attention when managing a limelight exhibition. An automatic regulator or screw-down adjustment valve regulator must be screwed into the valve of each cylinder (see "Cylinders, Gas"), it being necessary to reduce or check the pressure of the gas as it issues from the cylinder. High quality rubber tubing connections should be used, and if an automatic pressure regulator is not used, these tubes should not be tied on, in which case, also, the taps on the jets should be opened wide, and the whole of the adjustment done from the cylinder valves. A lime (see "Cylinders, Lime") is put in place, a small flame allowed to play upon it, and the lime

turned occasionally so that it gets warm right through, the object being to prevent cracking when the oxyhydrogen flame is turned on. Then the hydrogen flame is increased slightly, and the oxygen gently turned on, adjusting the two taps and the distance of lime from nipple until the best effect is observed upon the screen. Push in the jet or withdraw it from the condenser until there is an even field of light; if the jet is not central, there will be coloration or a shadow somewhere on the screen and the jet should be moved in the opposite direction to the defect until this is removed. Three minutes' experimenting will teach all that it is necessary to know in this matter. The adjustment of the light should preferably take place after a slide has been roughly focused and withdrawn. Always, when turning off the light, cut off the oxygen first, as otherwise there will be a slight pop in the hydrogen tube of a mixed jet.

It is advisable to retain a key on the valve stem of each cylinder so that in the case of a burst rubber tube or other similar accident the gas can be cut off immediately.

LIMES (See "Cylinders, Lime," and "Lime light.")

LINE DRAWINGS (See "Copying," "Copying Illustrations for Translation into Line Drawings," "Copying Stand," "Drawings Made from Photographs," and "Engravings, Copying.")

LINE NEGATIVES

Negatives of line drawings. Commercially, they were usually produced by the wet-plate process, but photo-mechanical gelatine dry plates are now widely used. A good test for a line negative is to lay it film side down on a sheet of white paper, and note whether all the lines and blacks on the original appear quite transparent. Veiled lines are sure to give trouble later. Every endeavour should be made also to secure negatives free from yellow stain, as this will retard the printing and make it difficult to obtain the correct exposure, so that the lines will wash away in the development of the prints, or if sufficient exposure is given to retain the lines there will be a difficulty in clearing the ground.

LINEN, MOUNTING PRINTS ON

In this work it is desirable to strain the fabric on a frame, and the prints need to be rubbed into close contact, as explained under the heading "Canvas, Mounting Prints on."

LINEN, PHOTOGRAPHS ON (See "Fabrics, Printing on.")

LINES IN COMPOSITION

What are spoken of as lines in the composition or arrangement of a photograph may not exist as actual lines at all. For instance, the tops of a row of trees would not be connected by a line, but they would none the less suggest one. Similarly, various masses suggest boundary lines which roughly enclose them, while detached objects, which carry the eye along from one to another, also suggest a line of direction. More

or less clearly defined lines may also be actually present—the horizon, the banks of a river, the edge of a path, tree trunks, hill-sides, roofs, and so on. The principal lines, present or suggested, are generally most evident when the print is viewed from such a distance that minor details do not obtrude themselves. The position, arrangement, and direction of these lines decide whether the general composition is satisfactory or otherwise. Even the points where certain lines reach the margins play an important part. A good arrangement generally results when the lines indicating the masses of the principal object, or objects, are grouped somewhere near the middle of the picture space, with the other principal lines radiating therefrom. The lines are unsatisfactory when they tend monotonously in one direction; when they are too symmetrical; when they lead the eye out of the picture towards the edges; or when they lead the eye to a part of the picture that does not contain the main objects.

Although no very definite rules can be laid down on this question of the lines of a subject, it is a good plan to make analyses of pictures in this way from time to time. No skill in draughtsmanship is required for the purpose. It is sufficient to mark out a space proportionate to the print under study, and mark, in their relative positions, the general (not detailed) outlines of the principal masses, and to add any lines that attract the eye, whether those lines are actually indicated or only suggested. The sort of pattern thus formed should then be studied, noting the way in which the eye is attracted to, or led to, certain points, and the effect that the lines have in suggesting harmony, monotony, contrast, stability and so on. By degrees a sort of instinctive perception of the principal lines of a subject will be acquired. (See also "Pictorial Composition.")

LINES, FRAUNHOFER (See "Fraunhofer Lines.")

LINING BEVELLER

A machine made by Royle, of Paterson, N.J., for bevelling half-tone plates, and forming ruled lines round them. The bevelling is done by means of a rotating head carrying two cutters, one of which makes the flat of the bevel, and the other parts off the waste margin of the metal. Another cutter, shaped like a graver, is arranged to work parallel to the bevel, and mechanical adjustments permit of the tool being placed at any distance from the bevel. Thus several lines can be made one after the other to form a border.

"LINKED RING," THE

The managing committee of the original Photographic Salon. The first Salon was held at the Dudley Gallery, London, in October, 1893, and there were annual exhibitions in that place until 1904; in 1905-9 the exhibition was held at the gallery of the Royal Society of Painters in Water-colours, London.

LINOTYPE

An early and now almost obsolete name for photographs on linen and other fabrics.

LIPPMANN'S PROCESS

A process of colour photography in which the phenomenon of stationary or standing waves is utilised. The process consists in exposing a transparent emulsion in contact with a reflecting surface, such as mercury. Prof. Gabriel Lippmann first used Taupenot's albumen process, and Krone, who has been extremely successful with this process, gives the following method:—

Albumen from whites

of 6 eggs	4 oz.	130 ccs.
Pot. bromide (10% sol.)	51 mins.	4'3 "
Liq. ammoniæ (strongest)	51 "	4'3 "

Beat to a froth, and allow to stand for twelve hours to liquefy, and then carefully decant or filter through some glass-wool. Unused glass plates should be thoroughly cleaned with alcohol, and then evenly coated with the above and drained, allowing them to dry in a horizontal position. When thoroughly dry they should be heated to 140° F. for two minutes, and then allowed to cool down to normal temperature and sensitised by bathing for two minutes in a 10 per cent. solution of silver nitrate acidulated with 10 per cent. of glacial acetic acid. The plates should next be washed for ten minutes and rinsed with distilled water, well drained, and colour-sensitised in one of the following baths:—

A. Chinoline red sol.		
(1 : 500)	27 mins.	1'6 ccs.
Cyanine sol. (1 : 500) 7 "		4 cc.
Ammonia (2% sol.) 50 "		3 ccs.
Distilled water to . 7 oz.		200 "
B. Erythrosine sol.		
(1 : 500)	17 mins.	1 cc.
Cyanine sol. (1 : 500) 17 "		1 "
Ammonia sol. (2%) 51 "		3 ccs.
Distilled water to 7 oz.		200 "
C. Chinoline red sol.		
(1 : 500)	25 mins.	1'5 ccs.
Malachite green sol.		
(1 : 500)	8½ "	5 cc.
Ammonia sol. (2%) 51 "		3 ccs.
Distilled water to 7 oz.		200 "
D. Erythrosine sol.		
(1 : 500)	17 mins.	1 cc.
Malachite green sol.		
(1 : 500)	17 "	1 "
Ammonia sol. (2%) 51 "		3 ccs.
Distilled water to 7 oz.		200 "

The plates should be bathed for three minutes in absolute darkness, allowed to drain for a minute or two, and then dried at 140° F. (60° C.). For normal work A is to be preferred, but with decreasing height of the sun B or D is better. The developer recommended is—

A. 10 per cent. alcoholic solution of pyro.		
B. Ammon. carbonate 772 grs.	50 g.	
Distilled water to 10 oz.	268 mins.	300 ccs.
C. 10 per cent. solution potassium bromide.		
For a 7 × 5 (13 × 18 cm.) plate, mix freshly of—		

A	128 mins.	7'5 ccs.
B	338 "	20 "
C	15 drops	15 drops
Distilled water 1 oz.	27 mins.	30 ccs.

When developed, wash and fix in a 1.5 solution of "hypo," and if the plate appears too thin, intensify with acid pyro and silver intensifier.

Valenta was the first to publish a gelatine emulsion formula:—

A. Distilled water	10 oz. 268 mins.	300 ccs.
Gelatine	. 154 grs.	10 g.
Silver nitrate	. 93 "	6 "
B. Distilled water	10 oz. 268 mins.	300 ccs.
Gelatine	. 309 grs.	20 g.
Potassium bromide	77 "	5 "

Heat both solutions to 95° F. (35° C.) and add A slowly to B with vigorous agitation. Valenta recommends pouring the emulsion immediately into 35 oz. or 1 litre of alcohol, stirring well with a glass rod and then washing for a short time in running water the precipitated emulsion, next placing in a vessel and adding enough water to make 21 oz. or 600 ccs., melting at as low a temperature as possible, filtering and coating the emulsion. Later he suggested coating the plates without washing the emulsion, and washing the plates when the emulsion had set. The sensitiser used was:—

Cyanine sol. (1:500)	68 mins.	4 ccs.
Erythrosine sol. (1:500)	34 "	2 "

and 1 to 2 parts of this were added to every 100 parts of the emulsion. Increase of sensitiveness was obtained by bathing the plates just before use in:—

Silver nitrate	. 48 grs.	5 g.
Glacial acetic acid	. 48 mins.	5 ccs.
Alcohol	. 20 oz.	1,000 "

Valenta also stated that the addition of 31 grs. or 2 g. of sodium sulphite to the above quantity of emulsion, and digestion for a short time, increased the sensitiveness without increasing the size of the grain.

Messrs. Lumière in 1893 published their method of making the emulsion, and valuable contributions also came from Valenta, Neuhauss, and Senior. The last named specially recommends the following:—

A. Nelson's No. 1 gelatine	. 77.15 grs.	5 g.
Distilled water	. 7 oz. 7 drms.	2.1 "
Potassium bromide	32.4 grs.	225 ccs.
B. Nelson's No. 1 gelatine	. 77.15 grs.	5 g.
Silver nitrate (re-cryst.)	. 46.29 "	3 "
Distilled water	7 oz. 7 drms.	225 ccs.

Bring each solution to 95° F. (35° C.), and add B to A with continual stirring.

Lippmann's later formula is as follows:—

Potassium bromide	. 8.1 grs.	.53 g.
Gelatine	. 62 "	4 "
Distilled water	. 3½ oz.	100 ccs.

For colour sensitising add:—

Alcoholic solution cyanine (1:500)	. 90 mins.	6 ccs.
Alcoholic solution chino-line red (1:500)	. 45 "	3 "

Mix the above at 95° F. and add:—

Silver nitrate (dry)	. 11½ grs.	.75 g.
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and stir until dissolved. Filter through glass-wool and coat the plates, allow to set, place each plate in alcohol, then wash for half an hour, drain, and dry. The plates will keep a long time.

Senior increases the general sensitiveness of the emulsion by adding to every 3½ oz. or 100 ccs., 3 grs. or .2 g. of silver eoside.

For fixing all plates a 15 per cent. solution of "hypo" may be used, or a 5 per cent. solution of potassium cyanide, but the latter must only be allowed to act for 15 to 20 seconds.

The heliochromes may be intensified with dilute mercuric chloride followed by amidol and sulphite, or the latter alone, and they may be reduced by a very weak "hypo" and ferricyanide bath.

One of the most exhaustive researches of the Lippmann process has been undertaken by H. E. Ives, whose conclusions will be found in the *British Journal of Photography* (1908).

As already stated, the sensitive film must be in contact with a reflecting surface such as mercury, and special dark-slides can be obtained commercially for this process. These have usually a hard rubber rebate in the front of the slide, against which the glass is pressed, and behind the film is another washer which clips the plate all round the edges so as to form, with the recessed back, a shallow trough into which the mercury is allowed to flow from a reservoir bottle connected with the slide by a rubber tube. Nothing but chemically pure mercury must be used, but even this is liable to oxidation, and this causes streaks and marks on the film on development. It is advisable, therefore, either occasionally to treat the mercury with sulphuric acid, which dissolves the oxide, or, better still, to form a bag of fine chamois leather by gathering together the ends and then shake the mercury to and fro in this, the leather having been thoroughly freed from grease by washing with soap and water and petroleum ether. In all cases it is advisable to rub gently the gelatine film of the plate after removing it from the dark-slide with a tuft of cotton-wool, to remove any adherent globule of mercury. In filling the slide with mercury great care should be taken to obtain an even flow of the latter, as stoppage in the flow will generally show as a line across the plate.

A finished heliochrome, when examined by looking through it, generally appears as a more or less dense negative of a brownish or brownish black hue, and it is only when looking at the film at a particular angle that the colours can be seen. As a rule they appear very pale, and they are actually diluted with white light reflected from the front surface of the film. For preliminary examination of the results the heliochrome may be immersed at an angle in a vessel containing benzole, but for permanent examination it is advisable to cement to the film (with Canada balsam or gum styra) a prism of glass of about 10° angle.

The pictures must be viewed by parallel light, and all side light cut off; this may be effected by cutting a hole in a window shutter and standing with the back to the hole with the heliochrome held in the hand at arm's length and shifted till it reflects the sky light. Obviously, somewhat similar results can be obtained by

enclosing the heliochrome in a box and reflecting sky light on to it by a mirror.

For projection on to a screen by means of a lantern the aphengoscope may be used.

LIQ. AMMON. FORT. (See "Ammonia.")

LIQUID GLUE (See "Fish-glue.")

LIQUID LENS (See "Fluid Lens.")

LIQUOR AMMONIÆ (See "Ammonia.")

LITHIA, CAUSTIC (See "Lithium Hydrate.")

LITHIUM BROMIDE (Fr., *Bromure de lithium*; Ger., *Bromlithium*)

LiBr . Molecular weight, 87. Solubilities, 1 in .6 water; very soluble in alcohol and ether. A white granular powder obtained by dissolving lithium carbonate in hydrobromic acid. It is very deliquescent, and must be kept in well-stoppered bottles. On account of its great solubility in alcohol and ether it is used in collodion emulsion making.

LITHIUM CARBONATE (Fr., *Carbonate de lithium*; Ger., *Lithiumcarbonat, Kohlen-saures Lithium*)

Li_2CO_3 . Molecular weight, 74. Solubilities, 1 in 75 water; insoluble in alcohol. A light, white granular powder, occasionally used in collodio-chloride emulsion making, and to form the other lithium salts.

LITHIUM CHLORIDE (Fr., *Chlorure de lithium*; Ger., *Chlorlithium*)

LiCl . Molecular weight, 42.5. The hydrated salt has the formula, $\text{LiCl} \cdot 2\text{H}_2\text{O}$. Molecular weight, 78.5. Solubilities, 1 in 2.5 water; very soluble in alcohol and ether. Colourless granular crystals obtained by dissolving lithium carbonate in hydrochloric acid. Used in collodio-chloride print-out emulsions.

LITHIUM HYDRATE (Fr., *Lithium caustique*; Ger., *Aetzlithium*)

LiOH . Molecular weight, 24. Soluble in water and slightly in alcohol. A caustic white powder, which readily absorbs carbonic acid from the air, and must, therefore, be kept well stoppered. Suggested by Lumière as the alkali for use with hydramine.

LITHIUM IODIDE (Fr., *Iodure de lithium*; Ger., *Iodlithium*)

LiI . Molecular weight, 134. Solubilities, 1 in .61 water; very soluble in alcohol and ether. A white coarse powder occasionally used in collodion emulsions. Very deliquescent.

LITHIUM TONER

A toning bath for gelatino-chloride paper (P.O.P.) but little used. The formula is:—

Lithium carbonate .	2½ drms.	17 g.
Gold chloride .	5 grs.	.6 "
Water .	20 oz.	1,000 ccs.

The bath is ready for use as soon as made. Prints should be washed before and after toning and fixed as usual.

LITHOGRAPHIC PHOTOGRAVURE

A photo-mechanical printing process, invented by Carl Eckstein, of The Hague. A polished lithographic stone is covered with an etching ground, and is then ruled with very fine lines, about .04 in. apart, scratched through the ground with a diamond point, operated by an engraving machine. The lines are then etched and filled with ink. A photo-lithographic transfer is next laid down over the lines, thus forming a kind of half-tone effect, and the stone is rolled up and printed from by the ordinary process of lithography.

LITHOGRAPHY (See "Photo-lithography.")

LITMUS

Synonym, lacmus. A colouring matter yielded by a process of fermentation from various lichens, and is obtainable in soluble violet-coloured lumps, a decoction of which is used to stain sheets of absorbent paper, which paper is cut up into strips and made up into little books. Litmus papers are used for testing the acidity and alkalinity of solutions, and those known in photography are of a blue or red colour, the blue for acids and the red for alkalis. Should red litmus paper be turned blue by a solution, this is proof that the solution is alkaline and not acid; but if it remains red the solution is either acid or neutral, to ascertain which blue litmus paper is introduced, this turning red if the solution is acid, but remaining unchanged if neutral. Although litmus paper is suitable for photographic purposes, it is a fact that some acids do not affect it.

Litmus paper should be kept in a tightly corked bottle, so as to exclude the air, and should the blue paper become red by exposure to air, as it sometimes does, the colour may be restored by holding it over the fumes of ammonia. Litmus is also made up in the form of a pencil, which is used for making a mark on a scrap of paper, which is then used in the same way as litmus paper.

LITRE

A standard measure of capacity in the metric system, equivalent to 1,000 cubic centimetres (ccs.), 1.7598 British pints, or 2.113 American pints. (See also "Weights and Measures.")

LIVER OF SULPHUR (See "Potassa Sulphurata.")

LOCAL DEVELOPMENT

The development of some portions of a negative to a greater extent than others. There are two methods of working, opposite in their character and effect. The first, which is more correctly termed "local development," consists in applying to certain parts of the negative a stronger solution than that in the dish, this being kept weak—that is, either dilute or containing but little alkali. The plate is taken from the dish, and some strong solution, kept separately in a measure, is applied by means of a soft camel-hair brush to the parts that are to be strengthened, taking care to prevent the strong solution from spreading or running; tilting the plate may sometimes help in this

connection. The negative must not be kept out of the developer for more than a minute at a time, and preferably less, there being always the risk of the solution settling in patches and of the developer in the film oxidising and causing stains. Therefore, it is best to brush the strong solution on the parts of the negative for about thirty or forty seconds, rinse the plate under the tap for a few moments, and return to the developing dish. After about a minute, the local work may be repeated, observing the same precautions, and then again repeated as many times as desired.

The second method consists in developing the plate in a normal solution and then, from time to time, applying a 10 per cent. solution of potassium bromide to those parts that need to be held back, taking all necessary care as explained in the preceding paragraph. This method is frequently employed for holding back the sky part of a negative, so that clouds may retain their printing value.

A serious objection to these methods is that the plate has to be exposed freely to the dark-room light, and it is almost impossible to avoid fogging. The photographer may decide, therefore, to adopt, instead, the methods given under the headings "Control in Printing," "Harmonising Contrasts," or even to adopt local intensification or local reduction, although the local application of chemicals to negatives is not advised if the desired results can be obtained by other means.

LOCAL INTENSIFICATION

Intensification of parts of a negative only, performed by applying solutions by means of a brush. It is desirable to select well-marked outlines at which the intensification should begin and end, and then to work carefully in a good light. The solution used must be one that can be applied perfectly evenly, or one in which slight unevenness will not show appreciably in the finished result. Intensification by means of mercuric bromide is suitable; first brush on the bleaching solution until the uneven markings caused by the brush disappear in an even bleaching. Then wash for a minute under the tap, next in a dish, and then immerse in the blackening solution in the usual manner. For strengthening only small parts of a negative the bleaching solution should be brushed on without previously wetting the plate. For larger parts, the plate should be soaked in water for half an hour before beginning to intensify. (See also "Intensification of Negatives.")

Local intensification is delicate work, and difficult to carry out successfully; while if it is unsuccessful the negative is ruined. In general, and if the photographer is not highly skilled, it is better to avoid local chemical treatment; similar results can often be secured without running risks by the methods that are described under the heading "Control in Printing."

LOCAL REDUCTION

Reduction of parts of a negative only, performed by brushing on solutions, as in the case of local intensification. For treating small parts only, work with the negative dry, and

continue to apply the solution with the brush until the reduction is sufficient. Great care must be exercised in keeping exactly to the outlines of the parts under treatment. On a large surface even working is easier after the plate has been soaked in water for half an hour. Compared with local intensification, the work is more easily controlled, and the solutions are less liable to deteriorate or produce erratic results by acting unevenly. The Howard Farmer reducer—"hypo" and potassium ferricyanide—is the most suitable for local treatment. As soon as the desired result is attained, the negative should be washed in two or three changes of water, and then placed in an acid "hypo" fixing bath for about ten minutes, finally washing as usual. Many of the notes on local intensification apply equally to local reduction.

LOCOMOTIVES, PHOTOGRAPHY OF

The general principles that govern the photography of machinery apply equally to such subjects as locomotives. (See "Engineering Photography.") Although, at times, a flat side view is required by engineers as a record of the elevation or outline of the engine, an oblique view will always make a more interesting photograph, taking it from the front end of the engine and showing the front buffer-beam very much foreshortened. For such a position a lens should be used having a focus at least one-third longer than the long side of the plate; and one of still longer focus will be preferable. Modern locomotives are so long that the far end is dwarfed considerably if a lens too short in focal length is used. The subject is long in proportion to its height, and unless the print is made very long and narrow there will be a wide expanse of foreground; but this assists in giving the impression of size and dignity. In order to give it its fullest value, a position should be chosen, whenever possible, in which this foreground consists of rails forming other lines in front of the engine photographed. A man standing near the cab of the locomotive will assist in conveying an idea of size, and an engine-driver or fireman in working clothes is the only suitable figure. The camera should not be more than 5 ft. from the ground, and a little less is generally preferable. A higher point of view dwarfs the engine.

LOGWOOD

A dye-wood obtained from the heart-wood of the logwood tree, *Hæmatoxylon campechianum*. The extracted dye is of a red colour, and known as "hæmatein." Under certain conditions a decoction of logwood will precipitate gelatine. It was used for experimental purposes in the early days of photography.

LORRAINE MIRROR (See "Claude Lorraine Glass.")

LUBRICANT

A mixture of Castile soap and alcohol is used as a lubricant when burnishing prints with a bar burnisher; and a solution composed of equal parts of linseed oil, liquor ammoniæ and

water has also been recommended. Encaustic pastes are sometimes referred to as lubricants. French chalk and blacklead are used for lubricating apparatus.

LU-METER

An instrument invented (1911) by J. S. Dow and V. H. Mackinney for the purpose of estimating the surface brightness of an object compared with the light of a standard candle, and for determining the necessary exposure required for such object.

LUMIÈRE, ANTOINE

Born 1839; died in Paris, 1911. Founder of the famous photographic firm of A. Lumière et ses Fils, which, with his two sons, Auguste and Louis, he established at Lyons in 1883.

LUMIÈRE COLOUR PROCESSES

Reference is made elsewhere to the starch grain process (*see* "Autochrome Process" and "Screen-plate Colour Photography"), but the brothers Lumière had worked out various processes before this. In the bleach-out process they suggested (1894) the use of cyanine, quinoline red and turmeric, and also a partial fixation of the results by means of metallic salts. In 1895, they exhibited prints produced from negatives taken through the usual set of red, green and violet screens, the positives being printed on bichromated films of gelatine or glue, soluble in cold water, which also contained some silver bromide or other inert insoluble matter, which increased the relief of the images. After development of the print, the silver bromide was dissolved out and the reliefs stained up and superimposed.

The process above described was introduced commercially, thin celluloid films being coated with the gelatine so that the printing could be done through the celluloid, thus obviating the necessity of double transfer or lateral inversion of the pictures.

In 1900, the brothers Lumière exhibited a series of fine prints produced by the superposition of bichromated reliefs on collodion supports, the following being an outline of the process: The screens for taking the negatives can be prepared by coating plate glass with a 10 per cent. solution of gelatine. When the gelatine is quite dry the plates should be immersed in the following baths, which should be at a temperature of 68° F. (20° C.), for about five minutes, then rinsed and dried. Two glasses of each colour should be cemented together with Canada balsam to form the screen:—

Green Bath

Methylene blue N
(.5 % sol.) . . . 2 oz. 411 mins. 143 ccs.
Auramine G (.5 % sol.) to 20 oz. 1,000 "

Blue-violet Bath

Methylene blue N
(.5 % sol.) . . . 10 oz. 500 ccs.
Distilled water to . . . 20 " 1,000 "

Orange Bath

Erythrosine J (.5 % sol.) 9½ oz. 474 ccs.
Metanil yellow (sat. sol.) to 20 " 1,000 "

The dish should be well rocked whilst staining up the gelatine. The above colours are obtainable, methylene blue from Casella, auramine G and erythrosine J from the Badische Anilin und Sodafabrik, and the metanil yellow from Hepp and Oehler. The papers are prepared as follows: Plate glass should be well cleaned, dusted with French chalk, edged with rubber solution, and then coated with an enamel collodion of the following composition:—

Alcohol . . .	9 oz.	444 ccs.
Ether . . .	11 "	556 "
Pyroxyline . . .	105 grs.	11 g.
Castor oil . . .	24 mins.	2.5 ccs.

When the collodion is dry, the plate should be immersed in a 7 per cent. solution of gelatine at 110° F., and a sheet of baryta paper cut to the same size also placed in the gelatine. The baryta side of the paper should be brought into contact with the collodionised plate, and the two thoroughly squeezed together and then dried. When dry, the back of the paper should be varnished with Soehnée's white varnish A, diluted with an equal quantity of alcohol. After twelve hours drying the paper should be coated with the following mixture:—

Emulsion gelatine . . .	2½ oz.	120 g.
Hard glue (Coignet) . . .	2½ "	120 "
Ammonium bichromate . . .	14 "	60 "
Potassium citrate, neutral (25 % sol.) . . .	.384 mins.	40 ccs.
Cochineal red . . .	9½ grs.	1 g.
Alcohol . . .	4 oz.	200 ccs.
Water . . .	20 "	1,000 "

Soak the gelatine and glue in the water and dissolve at 120° F., allow to cool down to 95° F., and then add the other ingredients, and finally the alcohol in small quantities. Filter the mixture and coat the paper, whilst on the glass, with the mixture, allowing about 90 mins. or 2 ccs. for every 100 sq. in. or 100 qcm. The paper is then thoroughly dried exactly as in the carbon process, stripped from the glass, and exposed beneath the three negatives, an actinometer being used to determine the duration of insolation. After exposure the print should be squeezed into contact with a sheet of glass which has been previously collodionised with the above-mentioned collodion, and then coated with a .75 per cent. solution of rubber in benzole. The coated glass and the exposed print should be immersed in a dish of cold water, squeezed into contact and placed under pressure for five minutes, then soaked in cold water for two hours so as to allow of complete expansion of the gelatine and paper. Development should be effected in water at 100° F., and the print allowed to soak for about half an hour, when the paper can be readily detached and the print developed as in the carbon process, and finally washed in cold water and immersed in alcohol for five minutes and dried. The relief prints thus obtained are dyed respectively red, yellow and blue, the necessary baths being as follows:—

Red Bath

Erythrosine J (3 % sol.) ½ oz. 25 ccs.
Water to . . . 20 " 1,000 "

Yellow Bath

Chrysophenine G	. 32 grs.	3.3 g.
Water	. 16 $\frac{3}{4}$ oz.	833 ccs.

Dissolve at 160° F. and add—

Alcohol	. 3 $\frac{1}{4}$ oz.	167 ccs.
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Blue Bath

Diamine blue F, pure (3 % sol.)	. 432 mins.	45 ccs.
Hard glue (15 % sol.)	. 1 $\frac{1}{4}$ oz.	63 "
Water to	. 20 "	1,000 "

The relief prints should be left in these baths for about twelve hours, then rinsed, and the red and blue impressions immersed in a 5 per cent. solution of cupric sulphate and then rinsed and dried. The yellow print must not be treated to the copper bath. It is possible to superimpose temporarily the images whilst on the glass supports and see if they are sufficiently stained; corrections can then be made by deeper staining, or washing out some of the dye. The dyed impressions should be coated with a 1.5 per cent. solution of rubber in benzole, then collodionised with a 1 per cent. collodion, and the yellow print transferred to paper by means of a warm 15 per cent. solution of gelatine, the paper being stripped when dry and the red and blue impressions superimposed on this also.

In a later process MM. Lumière suggested the making of the blue impression by conversion of the image of a bromide print by bleaching with potassium ferricyanide followed by ferric chloride, then coating this blue print with collodion containing tetrazotolylsulphite or tetrazoanisidinesulphite of soda and the chloride of β -naphthylamine-ether. Exposing under the red printing negative and the action of light produces the red image. Another coating with collodion containing diazo-orthotoluidine sodium sulphite with metamidophenol or resorcin gave the yellow image. MM. Lumière have also paid considerable attention to Lippmann's process

LUMINIFEROUS ETHER

An extremely elastic and subtle medium generally assumed to pervade all space and permeate all matter, the undulations of which, communicated to the eye, give rise to the sensation of light. Information of value in this connection is given under the headings "Light" and "Natural Colours, Photography in."

LUMINOUS PHOTOGRAPHS

Photographs which appear luminous or phosphorescent at night. They may be prepared in several ways. The simplest is that of making a positive transparency—as, for example, a lantern slide—varnishing the film side, and coating with luminous (Balmain's) paint. When dry, the transparency is backed with thin wood or cardboard, with a ring for hanging, and the whole bound together with strips of gummed paper or cloth. If exposed to light during the day the picture will appear luminous at night. Another plan is to spread a thin coating of glue upon cardboard and sprinkle with powdered barium or calcium sulphide, or to coat with Balmain's paint. A print is then made upon

thin sensitive paper which, after finishing in the usual way, is made transparent with castor oil, the excess blotted off, and the print attached to the treated cardboard with thin glue or strong paste, and dried by heat.

A method popular in Germany is to coat a piece of thin transparent celluloid with the following:—

Gelatine	. 436 grs.	100 g.
Potas. bichromate	. 48 "	11 "
Calcium sulphide	. $\frac{1}{2}$ oz.	55 "
Water	. 10 "	1,000 ccs.

The gelatine is soaked in the water, melted by heat, the other ingredients added and dissolved, and the mixture filtered through cotton-wool. When dry, the coated celluloid may be printed upon from a positive through the celluloid film, and the image developed in warm water in the same way as in the carbon process, a print being obtained which shows as a negative by transmitted light. This needs to be backed with black velvet or black paper, when it will appear as an ordinary black-and-white positive by daylight, and as a luminous or phosphorescent picture by night.

LUNAR CAUSTIC

A synonym for silver nitrate (*which see*).

LUNAR CORNEA

Latin for "Horn Silver." A form of silver chloride occurring naturally in an almost colourless mass, somewhat resembling horn, for which reason it received the name of *lunar cornea* from the old alchemists. It was first described by Fabricius (*d.* 1571), director of the college at Meissen, in a book on metals, published in 1556. It is often stated that Fabricius was the first to notice that horn silver became suddenly black on exposure to light, but, according to Major-General Waterhouse, none of his writings bears out this statement and, as a matter of fact, horn silver does not blacken suddenly, the change being gradual. (*See also* "Silver Chloride.")

LUNAR PHOTOGRAPHY (*See* "Moon, Photographing the.")**LUXOTYPE**

A half-tone process patented in 1883 by Brown, Barnes and Bell, a Liverpool firm of photographers. A photographic print was pressed against a metal plate engraved with a stipple in relief, it thus becoming embossed with a stipple. It was then strongly lighted from one side so that the stipple could be photographed, and a negative suitable for making a half-tone block was thus obtained. A modification of the process was to rub in the sunk parts of the embossed surface of the print with a pigment, so that it could be copied by direct lighting.

LYSOL (*Fr. and Ger., Lysol*)

A mixture of alkaline compounds of the higher phenols obtained by boiling a mixture of heavy tar oils, fat, and resin with alkalis. It is used chiefly as a disinfectant, and is soluble in water and alcohol.

M

MACHINERY, PHOTOGRAPHY OF (See "Engineering Photography.")

MACKENZIE-WISHART SLIDE

This is a special form of slide which makes possible daylight changing (*which see*). The plates are enclosed in light-tight envelopes.

MACROPHOTOGRAPHY (Fr., *Macrophotographie*, *Agrandissement*; Ger., *Makrophotographie*, *Vergrößerungs-verfahren*)

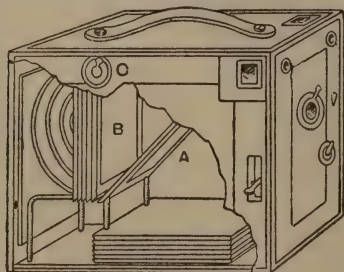
A term applied to enlarging with the solar camera; now synonymous with enlarging generally. The opposite of microphotography

MADDOX, RICHARD LEACH

Born at Bath, 1816; died at Southampton, 1902. He became well known for his work in photo-micrography, and was the originator of the gelatino-bromide plate. His experiments with gelatino-bromide of silver emulsion were published on September 8, 1871, and a modification of his process is in use to-day. The original plates were slow because the emulsion was not washed, and the lack of density was due to the absence of a restrainer and the presence of ammonia in the developer.

MAGAZINE CAMERA (Fr., *Chambre magasin*; Ger., *Magazinkamera*)

A camera carrying a number of plates or flat films in metal sheaths, with provision for exposing these successively. Magazine boxes and cameras for stand work were known as early as 1861, but such cameras are now mostly of the hand type. Many different changing systems are in use, the simplest being that having a



Magazine Camera

leather changing bag attached to the camera; this, although reliable, is somewhat slow in use, and automatic arrangements are now commonly preferred. The illustration shows the interior of a typical modern magazine camera, A being an exposed plate in its sheath, falling into the bottom of the apparatus, B the next plate in position ready for exposure, and C the changing lever. (See also "Hand Camera.")

MAGDALA RED (Fr., *Magdala rouge*; Ger., *Magdalaroth*)

Synonyms, naphthalene red, naphthalene rose; naphthalene scarlet, Sudan red, rose naphthylamine. A mixture of naphthyl-naphthor-induline and naphthyl-dinaphthosaframine hydrochlorides. It is a dark brown powder, soluble in alcohol and slightly soluble in boiling water. It has been used as a sensitiser for gelatine emulsions and gives a strongly marked maximum at the D lines, but the gap in the blue-green is wider than with erythrosine.

MAGIC CAMERA

An aphengescope, known also as the magic camera, named after the inventor, Kruss, of Hamburg. The original instrument was a tin

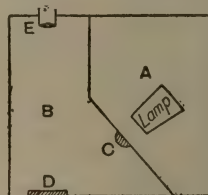


Diagram of Kruss Magic Camera

box divided into two compartments, A and B. In the division A was a lamp whose light was concentrated by a condenser C upon the object at D, an image of which was projected by the focusing lens E upon a screen.

MAGIC LANTERN (See "Optical Lantern.")

MAGIC PHOTOGRAPHS

Bleached photographs that suddenly appear on contact with a reagent. Of the possible processes, the easiest is to make a print on albumen paper, fix without toning, and to bleach in a solution of mercuric chloride. Soak pieces of blotting-paper in an ordinary fixing bath (a "hypo" solution), and, on placing the photograph between them and pressing together in the hands, the original image will once more appear.

MAGIC VIGNETTES (See "Black Vignettes.")

MAGILP (See "Megilp.")

MAGNALIUM (Fr. and Ger., *Magnalium*)

An alloy of magnesium, 15 to 20 parts, and aluminium, 100 parts, which is harder than aluminium, but not much heavier. It is easier to work, and has, therefore, been used for lens mounts, etc., instead of the pure aluminium.

MAGNESIUM (Fr., *Magnésium*; Ger., *Mag-nesium*)

Mg. Molecular weight, 24. A lustrous, silvery white metal, which is used in the form of powder and of ribbon for flashlight, etc. The light emitted by burning magnesium is extremely rich in actinic rays, and is the nearest in spectral composition to daylight of any artificial light; one-sixty-fourth of a grain of magnesium burnt in air gives as much photographically active light as 300 standard candles burning for one second, assuming that the light has to pass through the glass of a negative as in printing. (For information on using magnesium, see under the headings "Flash Lamp," "Flashlight Photography," etc.)

MAGNESIUM BEADS

Beads of dried paste, made with magnesium powder and distilled water, at one time used in an oxyhydrogen flame in much the same way as a lime to produce a powerful white light. They are not deteriorated by the atmosphere, as in the case of limes.

MAGNESIUM BROMIDE (Fr., *Bromure de magnésium*; Ger., *Brommagnesium*)

$\text{MgBr}_2 \cdot 6\text{H}_2\text{O}$. Molecular weight, 291. Solubilities, 1 in 1 water; slightly soluble in alcohol. It is in the form of colourless crystals, obtained by dissolving magnesium carbonate in hydrobromic acid, and crystallising; it is very deliquescent, and must be kept in well-stoppered bottles. Occasionally used in collodion emulsion making.

MAGNESIUM CARBONATE (Fr., *Carbonate de magnésium*; Ger., *Kohlensaures Magnesium*)

MgCO_3 . Molecular weight, 84. It is of small photographic interest, but, known as calcined magnesite, it is used in compressed blocks by photo-engravers for rubbing into the hollows of an etched plate, so that the state of the work may be seen. Also, in the form of a fine powder, it is used for the dry enamel process.

MAGNESIUM CHLORIDE (Fr., *Chlorure de magnésium*; Ger., *Chlormagnesium*)

MgCl_2 or $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$. Molecular weight, 94 or 202. Solubilities, 1 in .6 water, 1 in 5 alcohol. Colourless, bitter crystals or deliquescent mass obtained by dissolving magnesium carbonate in hydrochloric acid and evaporating; it is very deliquescent and must be kept in well-stoppered bottles. A 15 per cent. solution was suggested by Liesegang as a fixing agent, but it is not so powerful as "hypo." It is also occasionally used in collodion-emulsion making.

MAGNESIUM FLASHLIGHT MIXTURES

Mixtures of magnesium powder and other chemicals, particulars of which are given under the heading "Flashlight Powders."

MAGNESIUM IODIDE (Fr., *Iodure de magnésium*; Ger., *Iodmagnesium*)

$\text{MgI}_2 \cdot 8\text{H}_2\text{O}$. Molecular weight, 421. Soluble in water and alcohol. A deliquescent white crystalline powder that has been used in collodion-emulsion making.

MAGNESIUM LAMPS (See "Flash Lamp.")**MAGNESIUM LIGHT**

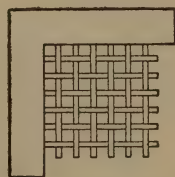
The light emitted when burning magnesium (*which see*).

MAGNESIUM POWDER

Metallic magnesium in the form of a silvery white powder. It keeps indefinitely, and should be stored in a well-corked bottle. For the methods of burning it see "Flash Lamp." It should be dried before use, as otherwise it will not fire properly. The impurities often present in it do not generally affect the value of the light, but they cause more smoke. Pure powder should feel soft and not gritty when passed between the fingers, and should not leave a dirty mark when rubbed on white paper.

MAGNESIUM RIBBON OR WIRE

Metallic magnesium in the form of ribbon or wire. Lamps are supplied for holding the ribbon, but it is sufficient to cut or break off the length required, hold in pincers or in any other way, and apply a light. The ribbon will give slightly more light, weight for weight, than the pure powder, unless the latter is burned in a form of lamp insuring complete combustion. When using magnesium ribbon for printing by contact, 1 in. of ribbon may be considered equal to four minutes' exposure to an ordinary flat gas flame at the same distance. The average weight of magnesium ribbon in this way was devised by McLellan in 1882, and an improved form was placed on the market by the Platino-type Co. in 1899. Ribbon tarnishes and, consequently, deteriorates quickly, and should be kept in an air-tight vessel; the tarnish can be removed by drawing the ribbon between smooth folded glasspaper. The ribbon gives off a considerable amount of smoke. Sometimes a pad of damp cotton-wool lint is supported over it, this absorbing most of the products of combustion.



Woven Magnesium Ribbon

A method of making ribbon into a net of coarse mesh has been recommended for convenience when burning a large quantity and to produce more even illumination, particularly when enlarging. Two L-shaped pieces of tinplate or copper are cut, and the ends of the strips of ribbon are then fastened on one of the L-shaped pieces by pasting on a strip of paper. When the mesh is complete, the other piece is clamped on top. The lower, free corner of the network may then be lighted, and the whole burns rapidly.

MAGNESIUM SULPHATE (Fr., *Sulfate de magnésium*; Ger., *Schwefelsaures Magnesium, Bittersalz*)

Synonyms, Epsom salts, bitter salts. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$. Molecular weight, 246. Solubilities, 1 in 1.5 water, insoluble in alcohol. It takes the form of small, colourless prisms or needles, obtained from sea water and certain springs, or by dissolving magnesium carbonate in sulphuric acid. It is used in making barium sulphate, and has an extraordinary hardening action on gelatine.

MAGNETOGRAPH (Fr., *Magnétographe*; Ger., *Magnetograph*)

An apparatus employed by meteorologists to give a photographic record of the oscillations of a magnetic needle.

Also the name applied to an image obtained on a photographic surface by means of a magnet, as explained in the next article.

MAGNETS, PHOTOGRAPHIC ACTION OF

The fact that magnets are capable of affecting a photographic (daguerreotype) plate was first asserted by Baron Karl von Reichenbach, about 1850. William Brooks, in 1877, placed a horse-shoe magnet, poles upwards, in a light-tight box, a blackened perforated card being supported $\frac{3}{8}$ in. above the poles, and a sensitive emulsion plate $\frac{1}{2}$ in. above the card. After leaving the plate for from 3 to 15 minutes, an image of the perforations on the card could be developed. Braham and others have also experimented in this direction.

MAGNIFICATION (Fr., *Amplification*; Ger., *Vergößerung*)

Degree of enlargement. A term used principally in photomicrography and telephotography. The diameter of the enlarged image divided by the diameter of the original equals magnification; or, in telephotography, the linear measurement of any object in the picture divided by the measurement of the same object as rendered by the positive lens alone. (See also "Photomicrography" and "Telephotography.")

MAGNIFIER (Fr., *Verre grossissant*; Ger., *Vergößerungsglas*)

A supplementary lens which increases or diminishes the focal length of the lens with which it is employed. The arrangement has advantages from the points of view of economy and convenience, as further explained under the heading "Supplementary Lenses."

MAGNIFIER, FOCUSING (See "Focusing Magnifier.")

MAHOGANYTYPE

A facetious term indicating the result of inserting an empty dark-slide into a camera, and going through the operations of drawing the shutter, making the "exposure," etc.

MALACHITE GREEN (Fr., *Vert Malachite*; Ger., *Malachitgrün*)

Synonyms B, solid O, benzaldehyde, new, Victoria, fast, diamond B, solid O, benzoyl or benzal green. Soluble in water and alcohol. It is a complex

aniline dye occurring in yellowish crystals with bluish-green reflection, or as a brown powder. It has been used as a sensitiser, and also for filters.

MALT PROCESS

Malt was one of the many preservatives recommended in the days of collodion plates. A mixture of 7 oz. of malt with 24 oz. of water was kept at a temperature of 156° F. (69° C.) for half an hour, allowed to cool, was then filtered, and finally applied to the plates.

MANGANESE DIOXIDE (Fr., *Péroxide de manganèse*; Ger., *Manganperoxyd, Braunstein*)

Synonyms, manganese peroxide or binoxide, black oxide of manganese. MnO_2 . Molecular weight, 87. Insoluble in water and alcohol. Occurs native. It is a heavy, black powder or in steel-grey lumps containing about 90 per cent. MnO_2 , used for flashlight powders and preparing oxygen.

MANGANESE PEROXIDE (See "Manganese Dioxide.")

MANGANESE, PRINTING WITH: ORGANIC LACTATE PRINTING

A novel printing process worked out by the Brothers Lumière in 1895. For the sensitising solution, 100 grs. of potassium permanganate are dissolved in 2 oz. of water, the measure being placed in cold water so as to keep the solution as cool as possible; $4\frac{1}{2}$ drms. of lactic acid are then added, a drop or so at a time, and the solution swirled round after each addition; these precautions will prevent the solution from becoming hot and frothing over. Allow to stand until all effervescence has ceased, and a thick brownish-black liquid results. Add a solution (cool) of 1 drm. of glucose or grape sugar in $\frac{1}{2}$ oz. of hot water, and filter through cotton-wool. The paper should be gelatine-coated, and fresh P.O.P., fixed and well washed, answers the purpose; it is prepared by applying the solution with a broad camel-hair brush and, after half a minute, blotting off the excess and drying in the dark. The paper must be evenly coated, and none of the solution allowed to reach the back. It yields a negative image from a negative, and, therefore, a good positive or lantern slide should be printed from; print in daylight. Develop by immersing the print in a saturated solution of aniline sulphate in water, to obtain a green colour; add a few drops of liquor ammoniæ for a violet colour. By using orthotoluidine sulphate solution, rendered slightly acid with hydrochloric acid, a deep blue image results; or, if the acid is replaced by liquor ammoniæ, a violet one. Paramidophenol develops an image something like an ordinary silver print. All the solutions used for developing should be as strong as possible. Development is complete in about thirty seconds, the prints being finished by washing in water.

MANGANESE SULPHATE (Fr., *Sulfate de manganèse*; Ger., *Schwefelsaures Mangan*)

Synonym, manganous sulphate. $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$. Molecular weight, 223. Solubilities, 1 in .8

water, insoluble in alcohol. It is in the form of transparent rose-red efflorescent crystals, obtained by dissolving manganese dioxide in sulphuric acid. It has been suggested as an addition to the bichromate sensitiser for carbon tissue, etc.

MARBLE MARKINGS

Stains that sometimes appear on wet collodion negatives, due to the film becoming partially dry before or during exposure.

MARBLE, PHOTOGRAPHS ON

Many methods have been advocated for reproducing photographs upon marble, but the best and simplest is by the carbon process (*which see*). Processes for sensitising marble and printing thereon direct have been worked, but with these there is the difficulty of examining the progress of printing.

MARÉCHAL'S COLLOTYPE PROCESS

The earliest colotype process worked out after Poitevin's experiments in Paris, 1856, was that of Tessié du Motay and Ch. R. Maréchal, in Metz, in 1865. Their method was similar in principle to that in use at the present day.

MAREY'S GUN (*See "Gun and Revolver Cameras."*)

MARINE PHOTOGRAPHY

The first supposed successful instantaneous photograph is of a marine subject—New York Harbour, taken in the 'fifties. In the same year Baron Gros, of Athens, made some daguerreotypes of breaking waves on the shores of Greece—in Phalerum Bay. Marine work in general resembles other hand camera work, but the exposures are short owing to the usually excessive brightness of the sea and sky. Backed plates should be used, and there is no necessity to have extra rapid plates; the consensus of opinion is in favour of isochromatic plates and the use of a pale yellow screen, but many workers prefer ordinary plates. The isochromatic plate should have the advantage on a bright day, and in the case of a blue sky. Should clouds be present (and these often make a seascape a success) there should be no difficulty in photographing them, inasmuch as sea and sky require about the same exposure, whereas in landscape work the foreground requires much longer exposure than the sky. Breaking waves, and seascapes with rocky or other dark foregrounds, are more difficult subjects because of the great differences in the correct exposures for the dark foreground and comparatively brilliant sea and sky. A foreground shutter—that is, a shutter allowing of the foreground receiving a longer exposure than the sky—should be an ideal accessory for such work; but when photographing breaking waves, the operator may not know whether the rocks in the foreground will remain in their natural state or be covered with a seething mass of white foam, a foam which would be whiter, and require less exposure than any other part of the picture. The shutter should work at such a speed as to give a naturalistic effect to the sea and waves. If a shutter works too fast the water will appear too sharp and have a frozen appearance, whereas

an exposure that is too long will show movement and the sea will be blurred. One-hundredth of a second is a good average speed, and if this is found to be correct the exposures may be otherwise corrected with larger or smaller stops. *F/16* is a good average stop, and with a medium plate and good diffused light (not bright sun) the exposure above mentioned will be about right. In brighter weather a smaller stop may be used and vice versa, and if the waves are comparatively quiet a longer exposure may be given.

Hand cameras of any kind are best for this work, and a good view-finder is essential; stand cameras are next to useless. Sea air affects leather and metal fittings considerably, and the camera should be protected as much as possible, especially from sea spray. Seascapes, particularly those with dark foregrounds, need careful development because of the great contrasts in the subject. A soft working and well-diluted developer should be used; adurol is good, while metol, with or without a little hydroquinone, has its advocates. If the dark parts lag behind, local development may be resorted to or the lagging parts helped by breathing upon them.

MARION'S GUM PROCESS

A modified form of carbon printing, now obsolete, similar to the modern "Ozotype," introduced by A. Marion, in 1873. Transfer paper coated with bichromated gelatine was exposed under a negative, and a visible image printed. The unsensitised carbon tissue and print were then immersed in a 2 per cent. solution of potassium or ammonium bichromate and squeezed together; after remaining under pressure for several hours, or until nearly dry, the carbon tissue was developed in the usual way. The reduced chromium compounds were absorbed by the tissue and produced a developable image exactly the same as though the tissue itself had been sensitised and printed. The advantage was that the printing on the paper could be watched and no transfer, as generally understood, was needed.

MARIOTYPE

A gum print produced by Marion's gum process.

MARS BROWN, MARS ORANGE, ETC.

Brown, orange, red and yellow pigments prepared from natural earths. The colouring property is chiefly due to iron oxide. They are occasionally used for colouring photographs.

MARTIUS YELLOW (*Fr., Jaune de Martius; Ger., Martiusgelb*)

Synonyms, Manchester yellow, naphthalene yellow, *jaune d'or*. Solubilities, soluble in water and alcohol. The sodium salt of dinitro-*a*-naphthol, which was used for making yellow screens.

MASKS AND MASKING

Masks, in the form of pieces of thin opaque paper pierced with openings, have various uses. In lantern slides a mask is used to shut off those parts of the image not required. It consists of

a square of thin paper the same size as the plate pierced with an opening corresponding with the amount of picture desired. (See "Lantern Slides, Masking, Binding, and Spotting.")

In printing, a similar mask is frequently applied to a negative, especially when printing a small picture with a broad white margin.

Masks of somewhat different character are very useful in combination printing, adding clouds to landscapes, etc.

MASTIC (MASTICH) (See "Gums and Resins.")

MATT PAPERS

Papers with a matt surface are made for almost all kinds of photographic printing, silver printing-out papers for daylight, and bromide and gaslight for working by artificial light. Carbon prints always have a slight effect of gloss in the shadows, even when developed on a rough surfaced paper. Platino-type prints, though devoid of gloss, are not absolutely matt; the print presents the actual surface of the paper without any film or coating to give the lifeless quality that distinguishes the true matt surface.

MATT SURFACE

A matt surface is one that is quite dull, not simply devoid of gloss like the natural surface of a good paper, but dead and smooth. It is considered by many to be more artistic than a glossy surface, but it possesses a serious disadvantage. The shadows of a print on matt paper are always devoid of depth and transparency, the darker details being all lost in one mass of uniform dark grey, and the dark masses of tone appearing dead or lifeless. The shadow details are visible while the print is wet, but they disappear as it dries. A very slight suspicion of gloss is sufficient to give depth and transparency to the shadows of a print, and to render the dark details in their true value.

MATT VARNISH

Generally used on the backs of negatives for softening the light, particularly in the shadows. A common practice is to coat the whole of the back of the negative with matt varnish, to scrape it away over the high lights, and either to paint on the varnish over the shadows with carmine water colour or to rub a soft lead pencil on the varnish. The two following formulæ will be found satisfactory, and the coarseness of the grain is dependent on the quantity of benzole added, so that it is advisable to add a small quantity first and test the grain:—

1. Gum sandarac	1½ oz.	70 g.
Gum mastic	144 grs.	15 "
Ether	15 oz.	750 ccs.

Dissolve and add—

Benzole to	20 oz.	1,000 ccs.
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If the ether is anhydrous, add to it—

Water	¾ oz.	50 ccs.
2. Gum sandarac	1 oz.	50 g.
Gum dammar	144 grs.	15 "
Ether	12½ oz.	625 ccs.

When dissolved, add—

Alcohol	10–50 mins.	1–5 ccs.
Benzole to	20 oz.	1,000 "

This makes a softer varnish than No. 1, and the alcohol gives a very fine grain. These varnishes are coloured yellow by adding to every 200 parts 1 part of aurantia or chrysoidine. Asphaltum gives a brown colour.

MAXWELL (See "Clerk-Maxwell.")

McDONOUGH'S COLOUR PROCESS

A process of screen-plate photography patented by McDonough, of Chicago, in 1892, and introduced for a brief period in 1897. Sheets of glass were ruled with alternate lines of red, green, and blue-violet, and placed in front of a panchromatic plate during exposure. The exposed plate was then developed in the ordinary manner, and positives made therefrom which were bound up with similarly ruled viewing screens. In consequence of the somewhat coarse ruling of the lines, they were rather obtrusive, and owing to the want of absolute contact between the viewing screen and the photographic positive parallax existed, so that the colour of an object changed with the angle at which the picture was viewed.

MEALINESS

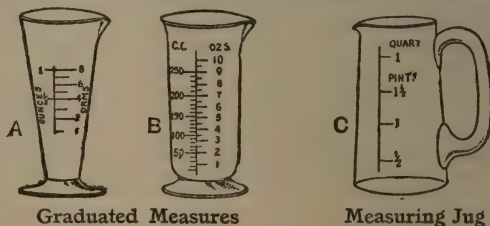
Albumen paper that has been sensitised in a bath weak in silver has a mealy appearance when printed, and density and brilliancy are lacking. Very rarely a badly made toning bath and one weak in gold will cause mealiness. Improperly kept platinum paper also gives mealy effects.

MEASLES

A peculiar defect met with in all kinds of printing-out papers, but usually with albumen paper. The prints have a mottled appearance, and on being viewed by transmitted light the interior of the paper appears to be covered with opaque blotches, which, if allowed to remain, will afterwards discolour. The cause is generally a weak "hypo" fixing bath, or insufficient or acid fixing, but sometimes it is fixing in a strong light. The measles spots cannot be cured when once they appear, but they may be prevented by fixing thoroughly, and the use of an alkaline bath.

MEASURES, GRADUATED (Fr., *Mesure graduée*, *Vase gradué*; Ger., *Mensur*, *Messglas*)

Vessels of glass, opal or celluloid of various



Graduated Measures

Measuring Jug

shapes, used for measuring solutions. They are graduated either in ounces and drams, as at A,

or in cubic centimetres, a combination form B containing both scales being also made. Those of white glass with black graduations are most visible in the dark-room. Measuring jugs C are convenient for large quantities. (See also "Burette," "Dropping Bottle," etc.)

MEASURES, WEIGHTS AND (See "Weights and Measures.")

MEDALLIONS, ETC. (See "Bas-reliefs" and "Coins and Medals, Photographing.")

MEDICAL PHOTOGRAPHY

Every year sees the wider application of photography to medical science. At the present day photomicrography and radiography are of the very greatest importance, the first making it possible to obtain a permanent and exact record of the normal and abnormal appearance of the tissues, of the blood corpuscles, and of those blood-parasites and bacteria which are the cause of various diseases; while the second assists in the diagnosing of fractures of the bones, the presence of foreign bodies within the thoracic and abdominal regions, and calculi in the kidney, etc., etc. Radiography is fully treated under the heading of "X-Ray Photography," but the application of photomicrography to medical research calls for some consideration here. The microscope must have a centring sub-stage, and should also have a good mechanical stage fitted with vernier scales which act as "finders." The most useful objectives will be, for medium and high-power work, a $\frac{1}{4}$ th, $\frac{1}{2}$ th, and $\frac{3}{4}$ th in. oil immersion; while for large sections and low-power work generally, a 2 in., 1 in., and $\frac{1}{2}$ in. The selection of eyepieces will be governed by the type and quality of the objectives. It is most important that both eyepieces and objectives be kept perfectly clean and free from dust, dust on the lenses of the eyepiece giving rise to the appearance of out-of-focus marks on the negative. The sub-stage condenser must also be carefully cleaned from time to time. As it is important to bring out as much detail as possible in the resulting negative, and all pathological and bacteriological preparations are stained with one or more stains, it is absolutely necessary not only to use carefully and thickly backed orthochromatic plates, but also suitable compensating filters, that the maximum amount of detail, coupled with sufficient contrast, may be obtained. While visual observation of the subject, with the compensating filter placed immediately behind the sub-stage condenser, will serve as a rough guide to the amount of detail and contrast likely to be obtained, unless the dyes used for the filter are spectroscopically true, and the photographic plate properly orthochromatised, the photographic result will not be as satisfactory as the visual examination promised. Long experience has shown that the most satisfactory results, as regards both the quality and resolution of the image, are to be obtained with a camera extension of 10 in. from the eyepiece of the microscope to the focusing screen of the camera. In photographing such subjects as skin eruptions and rashes, careful attention must be paid to the colour of the

eruption. For instance, a pink, yellow, or red rash will show up much better if photographed with an ordinary plate of medium speed, than with an orthochromatic plate, for the simple reason that the ordinary plate being less sensitive to these colours, they will be rendered darker, and, therefore, more conspicuous, than if photographed on an orthochromatic plate. To photograph culture tubes of bacteria that have been inoculated by "stab" or "streak," place the tube in a large water bath or lantern alum trough filled with water. This will be found to do away with the unpleasant, bright, vertical reflections down the front and sides of the culture tube, and to facilitate the successful photographing of the growth within the tube.

MEDIUMS

The composition of mediums for colouring, retouching, and spotting are given under separate headings.

MEGASCOPE (See "Aphengescope.")

MEGATYPE (Fr., *Mégatype*; Ger., *Megatypie*)

A term at one time applied to a process of enlarging, and to the resulting enlargements.

MEGILP

Synonyms, M'Guilp, magilp, and magilph. A mixture of linseed oil and mastic varnish, used as a medium for oil colours and occasionally for rubbing upon platinotype and bromide prints for the purpose of increasing the depth and richness of the shadows.

MEISENBACH PROCESS

The earliest half-tone process commercially exploited. By the method patented in Germany in May, 1882, by Josef Ritter von Schmaedel and G. Meisenbach, a single-line screen was made from the proof of an engraved plate ruled with lines, and the screen was placed in front of a photographic positive of the picture and the two photographed together. Half-way through the exposure the screen was turned so that the lines crossed. A half-tone negative was thus obtained from which a zinc block was made. Afterwards the process was modified by placing the screen in front of the sensitive plate and photographing direct from the original print, the screen being turned half-way as before.

MELAINOTYPE

An early name for the ferrotype process.

MENISCUS LENS (Fr., *Ménisque*; Ger., *Meniskus*)

The concavo-convex lens. (See "Concave Lens" and "Convex Lens.")

MERCURIAL INTENSIFICATION (See "Intensification of Negatives.")

MERCURIC BICHLORIDE (See "Mercuric Chloride.")

MERCURIC CHLORIDE (Fr., *Bichlorure de mercure*; Ger., *Quecksilberchlorid*)

Synonyms, perchloride or bichloride of mercury, corrosive sublimate. HgCl_2 . Molecular

weight, 271. Solubilities, 1 in 16 water, 1 in 3 alcohol, 1 in 12-14 ether. White crystalline masses or small crystals prepared by dissolving calomel in hydrochloric acid. Very poisonous, the antidote being white of egg, followed by an emetic. Its solution is decomposed by light, and should therefore be kept in the dark. It is used as the bleaching agent in mercurial intensification.

MERCURIC IODIDE (Fr., *Iodure de mercure*; Ger., *Quecksilberiodid*)

Synonym, red iodide of mercury, biniodide of mercury. Hg I_2 . Molecular weight, 454. Solubilities, insoluble in water, 1 in 116 alcohol, 1 in 85 ether, very soluble in potassium iodide solution. A heavy scarlet red amorphous powder precipitated from mercuric chloride solution by potassium iodide. Poisonous (see "Mercuric Chloride" for antidotes). It is used in intensification, and is then usually prepared direct as follows:—

Mercuric chloride	. 54 grs.	6 g.
Potassium iodide	. 33 "	4 "

Dissolve each in a little water, mix, and add—

Sodium sulphite	. 4 oz.	220 g.
Water to	. 20 "	1,000 ccs.

Mercuric and Potassium Iodide, $\text{HgI}_2 \cdot 2\text{KI}$, is sometimes used instead of the above, and can be made by adding 2 parts of potassium iodide to 1 part of mercuric iodide in dry powder, or it can be made in solution by adding 99 parts of potassium iodide to 54 parts of mercuric chloride.

MERCURIC PERCHLORIDE (See "Mercuric Chloride.")

MERCURIC AND POTASSIUM IODIDE

This is described under the heading "Mercuric Iodide," above.

MERCUROGRAPHY

Many lithographic processes have been based on the fact that if those parts of a zinc plate which are not covered with ink are treated with mercury or a mercuric salt, the amalgam formed has the property of repelling ink.

MERCURO-URANOTYPE

A printing process (practically obsolete) in which uranic salts are employed, they being sensitive to light. Two saturated solutions, of uranium chloride and mercuric chloride respectively, are required; 1 oz. of the first is mixed with 1 dram of the second and applied to paper, which is next dried in the dark. After printing, the paper is toned by floating on a very weak solution of gold chloride or potassium chloroplatinite, immersed in very dilute hydrochloric acid, and finally washed in plain water. (See also "Uranium Printing.")

MERCUROUS CHLORIDE

Synonym, calomel. Hg_2Cl_2 . Molecular weight, 471. Prepared by precipitating a solution of mercurous nitrate with a solution of sodium chloride, and of but the slightest photographic interest.

MERCURY (Fr., *Mercure*; Ger., *Quecksilber*)

Synonym, quicksilver. Hg. Molecular weight, 200. Solubilities, insoluble in alcohol and water, soluble in nitric acid and hot sulphuric acid. A heavy, silvery liquid element found native or obtained by roasting its ore, cinnabar. It was used as the developer in the daguerreotype process, and is also used in the Lippmann process.

MERCURY BATH

A dark box in which daguerreotypes were developed by mercury fumes. The mercuric chloride solution used for intensifying gelatine negatives is also known by this term.

MERCURY INTENSIFICATION (See "Intensification of Negatives.")

MERCURY PRINTING

By this process of printing (now obsolete) pure mercury is covered with nitric acid, and in the course of a few days the thick crust of moist crystals which will form should be removed and dried, as much as possible, on blotting-paper. Dissolve 230 grs. of these crystals in 5 oz. of water, and add nitric acid to dissolve any precipitate. Coat plain paper with starch paste, dry it, and in a very weak light float it on the above solution. Dry quickly and keep until required in a calcium tube. Print for two or three minutes and develop in:—

Ferric sulphate	. 65 grs.	15 g.
Tartaric acid	. 65 "	15 "
Water	. 10 oz.	1,000 ccs.

Fix for five minutes in a solution of 90 grs. of sodium chloride in 4 oz. of water, and tone the greyish image to a black one in:—

Potassium chloroplatinite	. 3 grs.	1 g.
Tartaric acid	. 60 "	20 "
Water	. 7 oz.	1,000 ccs.

MERCURY SULPHOCYANIDE (Fr., *Sulfo-cyanure de mercure*; Ger., *Rhodanquecksilber*)

Synonyms, mercuric sulphocyanate and rhodanide. $\text{Hg}(\text{SCN})_2$. Molecular weight, 316. Solubilities, slightly soluble in water, soluble in alcohol and solutions of alkaline chlorides and sulphocyanides. Poisonous (see "Mercuric Chloride"). It is a white powder, but is easily prepared in solution as follows:—

Mercuric chloride	. 2 oz.	100 g.
Potassium sulphocyanide	. 768 grs.	80 "
Distilled water to	. 22 oz.	1,000 ccs.

For use dilute 1 part of the above with 10 parts of water. It is used as an intensifier for negatives, and gives a good black image, but it is preferable to apply a developer afterwards

MERCURY THERMO REGULATOR

For collotype ovens and drying boxes heated by gas a heat regulator, which depends on the expansion of mercury, is sometimes used. The simplest form consists of a U-shaped tube containing mercury A. Branch B is attached by a

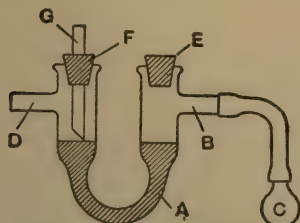


THE MOON

PHOTOGRAPHED AT THE PARIS OBSERVATORY

CELESTIAL PHOTOGRAPHY

rubber tube to a glass bulb C inside the drying box. Branch D is connected to the burners. E F are rubber stoppers, a glass tube G passing through F to the gas supply, whilst its end inside

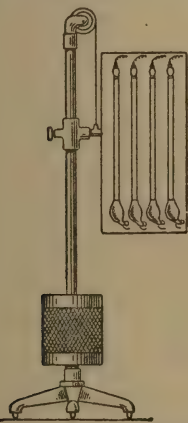


Mercury Thermo Regulator

the U-tube is ground off at an angle. As the mercury expands through the heating of the bulb inside the box, the sloping end of the tube G is more or less closed, thus regulating the gas supply.

MERCURY VAPOUR LAMP (Fr., *Lampe à vapeur de mercure*; Ger., *Quecksilberlampe*, *Quecksilberdampf Lampe*)

A lamp in which the vapour of mercury in a vacuum tube is raised to incandescence by the passage of an electric current. The illustration shows the Cooper-Hewitt lamp. In this, four tubes are supported in a frame on an upright stand, the mercury being contained in the large bulbs, which form the negative ends



Mercury Vapour Lamp

or cathodes. When the switch has been closed the tubes are reversed, so that the mercury runs to the opposite end. This short-circuits the two electrodes and the tubes immediately light up, being then returned gradually to their previous position. The lamp must not be left with the bulbs uppermost; and the tubes must be connected up to the right polarity, or they will be destroyed in a few minutes. The light obtained is highly actinic, being rich in violet rays, and excellent for copying, printing, and enlarging. Owing to its great diffusion and coolness it is well suited for portraiture, the sole objection being the ghastly colour of the light. This effect is visual only, and does not appear in the photograph; since it is due

to the absence of red rays, it is easily rectified by using a few ruby or light-red incandescent lamps in addition. (See also "Electric Light.")

In process work, this lamp has been used for process copying and printing, but the liability of the tubes to break down rendered its general employment impracticable, and, on the point of economy, tests showed that whilst the lamps only took one-fourth of the current of "enclosed" arcs the exposure was four times longer, so that there was actually no gain. An advantage of the mercury lamps was, however, that in photographing wash drawings in which Chinese white had been used the reproduction was much more faithful than that obtained with arc lamps. For printing purposes with bichromate films the exposures were not more rapid than with the enclosed arc on account of the absorption of much of the actinic intensity of the light by the yellow stain of the bichromate.

MERCURY-SILVER PRINTING

A process of French origin (1892). Paper is floated on a solution of $\frac{1}{2}$ oz. of mercuric chloride in 6 $\frac{1}{2}$ oz. of distilled water. It is washed, dried, and sensitised on a bath of 48 grs. of silver nitrate in 1 oz. of distilled water. The paper, when dry, is printed under a negative for about a minute, and developed with the following, after which it is washed, fixed in "hypo," and again washed:—

Acetic acid	.	.	$\frac{1}{2}$ oz.	37 g.
Ferrous sulphate	.	.	$\frac{1}{2}$ "	37 "
Water	.	.	15 "	1,000 ccs.

METAFORMALDEHYDE (See "Trioxymethylene.")

METAGELATINE (Fr., *Metagelatine*; Ger., *Metagelatin*)

A name given by Lyte, in 1857, to a solution of gelatine boiled with dilute acid, usually sulphuric, so that it has entirely lost its setting power. The acid was subsequently neutralised with chalk, and the solution filtered and used as a preservative in the old collodion dry process.

Many vain attempts have been made to substitute metagelatine for fish glue in the enamel photo-engraving process.

METAL DISHES (Fr., *Cuvettes métalliques*; Ger., *Metallplatten*)

Enamelled iron or steel dishes are used for heating the alum-"hypo" toning bath, and for hot-bath platinotype, as well as for other purposes. Compared with porcelain dishes of similar size, they are light, unbreakable, and readily cleaned. The only danger is the chipping of the enamel, in which event the solutions act on, and are affected by, the iron beneath. Enamelled dishes will, however, last a long time without this happening, with ordinary care. If the fault is suspected, a little dilute sulphuric acid may be poured in the dish, when small bubbles of hydrogen gas will arise from any part where the metal is exposed. Leaden dishes are sometimes used for stripping solutions containing hydrofluoric acid.

METAL, PHOTOGRAPHS ON

Photographs may be obtained on metal by the bitumen process (see "Heliography" and "As-

phaltum"), or on silver plates by the daguerreotype process. Ferrotypes—collodion photographs on enamelled sheet-iron—are another familiar instance. Carbon prints may be developed on metal plates as a final support, giving very effective results.

METALLIC FILMS, FLEXIBLE

A process invented in 1892 by Brandweiner and Lautensall, of Vienna. A photographic image is obtained on a highly polished copper or brass plate, which is then etched, the protecting film removed, and a polished image is seen on a matt ground. A deposit of some metal is now electrically produced, a sheet of paper, linen, etc., is made to adhere, and both sheet and thin metal deposit stripped off, leaving the plate ready for making another duplicate.

METALLIC SPOTS (See "Black Spots.")

METAMORPH PRINTS

Distorted or trick photographs produced either by warming the wet film and partially melting it, taking the film off the plate and stretching it, or by the use of curved mirrors. (See also "Anamorphoscope.")

METEOR PHOTOGRAPHY

The photographic delineation of meteors or shooting-stars forms one of the most fascinating branches of astronomical study. The fact that one of these visitors from outside space may flash through our atmosphere at any moment lends additional zest to the attempts made to portray them; the only help one has to prepare for them is that past experience has shown that they occur in families, as it were, at certain fixed times of the year, and more or less concentrated in definite regions of the sky. Thus we have the Perseids in August, radiating in all directions from the constellation Perseus, and the Leonids in November, radiating from the sickle-like constellation of Leo. Apart from this help as to probable time and location, one must trust to patience and an ever-ready camera. The camera must be directed to the sky with the lens open, and immediately a meteor is seen to cross the field, the lens is capped and the plate developed. No special apparatus or plates are necessary; the most rapid plates and a wide-angle lens of as large an aperture as possible are to be recommended. If the observer is fortunate, he may chance to photograph a fireball, that is, a meteorite in the act of exploding owing to the heat developed by friction with the atmosphere.

METEOROLOGICAL PHOTOGRAPHY (Fr., *La photographie météorologique*; - Ger., *Meteorologische Photographie*)

Photography is of great service to the meteorologist in connection with automatic recording instruments, among which may be mentioned the photo-barograph, or barometrograph, which registers the fluctuations of the barometer; the thermograph for recording changes of temperature; the psychrometer, a measurer of the amount of watery vapour in the air; and the magnetograph, for indicating the oscillations of the magnetic needle. Photography is also employed to record the positions and forms of

clouds, in making observations of the solar spectrum, etc.

METER (See "Actinometer," "Exposure Meter," "Opacity Meter," etc.)

METHOL

An early name for the metol developer.

METHVEN SCREEN

A sheet of metal pierced with an aperture placed in front of a standard light to limit the effective portion to the part which burns the most steadily, this usually being at the centre

METHYL ALCOHOL (See "Alcohol.")

METHYL ORANGE (Fr., *Hélianthine*; Ger., *Methylorange*)

Synonyms, dimethylaniline orange, gold orange, tropæoline D, orange III, helianthine, Poirrier's orange 3 P. Soluble in water. Sodium or ammonium dimethylaminoazobenzenesulphonate. A yellowish powder giving an orange-coloured solution, which is not affected by carbonic acid, turned bright red by mineral acids and yellow by alkalis. It has been suggested for making yellow screens. It is also the mother substance from which eikonogen is prepared.

METHYL VIOLET (Fr., *Violet de méthyle*; Ger., *Methylviolet*)

Many dyes are known under this name, and they are distinguished from one another by the suffix 5B, 4B, etc., R, 2 R, 3R, B meaning that the dye has a more or less bluish shade which is shown by the figure affixed to the B; whilst R means red, the increase in red being shown by the figures. They are essentially mixtures of the hydrochlorides of pentamethylrosaniline and hexamethylpararosaniline. They generally occur in greenish glistening crystals or lumps, very soluble in water and alcohol. Used for making three-colour screens.

In process work, methyl violet is used for dyeing the print in the fish-glue enamel process, so that the progress of development may be seen.

METHYLATED ETHER (See "Ether.")

METHYLATED SPIRIT (See "Alcohol.")

METHYLCATECHOL (See "Guaiacol.")

METHYLENE BLUE (Fr., *Bleu méthylène*; Ger., *Methylenblau*)

Synonyms, methylthionine or tetramethylthionine hydrochloride. Soluble in water. A dark-green crystalline powder used for making the blue screen, and also the blue positive print, in three-colour work. Various shades of the dye are distinguished by the suffixes, B, BB, R, RR, etc., as with methyl violet.

METHYLEOSINE

The "BN" or "Scarlet B" variety of eosine, giving with water a scarlet solution.

METHYLIC ALDEHYDE (See "Formaline.")

METHYLPYROCATECHIN

A synonym for guaiacol.

METOL (Fr. and Ger., *Metol*)

A salt, generally the sulphate, of methylparamidophenol $C_6H_4(OH)(NHCH_3)$ according to Andresen, and of methylparamidometa-cresol $C_6H_3(OH)(CH_3)(NHCH_3)$ according to Hauff. It is a white, greyish or pinkish-white powder easily soluble in water. When mixed with an alkali it forms an energetic developer.

bromide) is often advisable. Sodium hyposulphite may be used with caution in any metol developer, and Eder recommends the addition of from 2 to 4 per cent. of a 10 per cent. solution for obtaining great contrasts and preventing fog.

Metol is largely used in combination with pyrogallic acid, hydroquinone, glycine and other developers, and formulæ for these combined

	METOL.		METOL—HYDROQUINONE.			
	1. <i>Andresen</i> One- solution.	2. <i>Hauff</i> One- solution.	3. <i>Average</i> One- solution.	4. <i>One-solution</i> <i>for</i> <i>Winter Use.</i>	5. <i>One-solution</i> <i>for</i> <i>Bromide Paper.</i>	6. <i>One-solution</i> <i>for</i> <i>Gaslight Papers.</i>
Metol	180 grs. 20 g.	130 grs. 15 g.	15 grs. 17 g.	75 grs. 85 g.	50 grs. 6 g.	20 grs. 22 g.
Sodium sul- phite	3½ oz. 195 „	3 oz. 70 „ 173 „	1 oz. 55 „	1½ oz. 70 „	1 oz. 55 „	700 „ 80 „
Potassium bromide	22 grs. 25 „	8½ „ 1 „	5 grs. 6 „	10 grs. 12 „	10 grs. 12 „	7 „ 8 „
Potassium carbonate ...	600 „ 70 „	550 „ 63 „	1½ oz. 82½ „	— „ — „	— „ — „	— „ — „
Hydroquinone	— „ — „	— „ — „	60 grs. 7 „	38 grs. 44 g.	25 grs. 3 g.	50 grs. 6 g.
Sodium car- bonate	— „ — „	— „ — „	— „ — „	— „ — „	1 oz. 55 „	700 „ 80 „
Sodium hy- drate	— „ — „	— „ — „	— „ — „	150 grs. 17 g.	— „ — „	— „ — „
Water	20 oz. 1,000 ccs.	20 oz. 1,000 ccs.	20 oz. 1,000 ccs.	20 oz. 1,000 ccs.	20 oz. 1,000 ccs.	20 oz. 1,000 ccs.
For use	Mix 1 part with 3 parts of water.	Mix 1 part with 1 to 2 parts of water.	Ready for use for negatives.	Ready for use.	Ready for use; may be diluted.	Ready for use; do not dilute.

On account of the rapid appearance of the image there is a risk of taking the negative from the developer too soon. In accordance with the factorial system of development a negative developed with metol must be allowed to remain in the developer about thirty times as long as the image takes to appear, and density will then be assured. The table given above includes formulæ for one-solution developers, and the formulæ here given are for two-solution developers:—

Two-solution Developers
(*Andresen*)

- A. Metol . . . 180 grs. 20 g.
Sodium sulphite . . 3½ oz. 195 „
Water . . . 20 „ 1,000 ccs.
B. Sodium carbonate 560 grs. 64 g.
Water . . . 20 oz. 1,000 ccs.

For use, take 1 part of A and 3 parts of B.

(*Hauff*)

- A. Metol . . . 130 grs. 15 g.
Sodium sulphite 3 oz. 70 grs. 173 „
Water . . . 20 oz. 1,000 ccs.
B. Sodium carbonate 3 oz. 70 grs. 173 g.
Potassium bromide 14 grs. 16 „
Water . . . 20 oz. 1,000 ccs.

With regard to Hauff's two-solution developer above, for normal exposures and quick and vigorous development, take equal parts of A and B; but for slow development take equal parts of A, B, and water, and add to each 3½ oz. of mixed developer, 5 to 10 drops of either a 10 per cent. solution of potassium bromide, or of a 10 per cent. solution of sodium hyposulphite. When using this modified developer density and detail (surface and depth) develop approximately simultaneously. The addition of a few drops of citric acid (which is a more powerful restrainer than potassium

mixtures will be found under the heading "Developers, Mixed," as well as, in the case of metol-hydroquinone, in the table which is given above.

Metol has an irritating effect upon some skins, and it is, therefore, wise not to wet the fingers with the developer more than is necessary. The irritation is sometimes felt when metol is used for the first time, but generally it is not experienced until metol has been used frequently over a long period. It is wise to discard metol immediately the trouble occurs, as the pain and inconvenience are likely to increase every time the metol is used. The hands should always be washed with warm water and soap, preferably carbolic, after using metol, and wiped with a dry, soft towel. Many remedies for the disease have been recommended, such as rubbing the fingers with lemon juice, vaseline, cold cream, etc., when the itching is first felt. An ointment (to be made up by a chemist) specially recommended is:—

- Mercuric nitrate . . 60 grs. 60 g.
Carbolic acid . . 10 mins. 10 ccs.
Zinc oxide . . . 30 grs. 30 g.
Lanoline . . . 1 oz. 480 „

The fingers should be smeared with the above at night, and an old pair of kid gloves worn. Coal-tar ointment is also recommended.

METOL-HYDROQUINONE (METOL-QUINOL)

A mixture of metol and hydroquinone is a popular developer, being clean in working and suitable for most kinds of plates and bromide and gaslight papers. It is sometimes known as metol-quinol, quinol being another name for hydroquinone. Scores of one, two, and even three solution formulæ have been given, but

there is very little difference between them. Taking a dozen of the best known formulæ, the average one-solution developer is as No. 3 in the table given in the preceding article, this developer being ready for use and of the correct strength for negatives, lantern plates and gaslight papers, but when used for bromide papers an equal amount of water is required. The hydroquinone and metol are not in equal proportions, but many prefer to have the hydroquinone in excess, the metol being the more expensive of the two. The proportions may be altered to suit the temperature, it being advisable to have more metol than hydroquinone in cold weather, because hydroquinone is apt to work very slowly in winter, especially when sodium carbonate is used, and, moreover, is apt to crystallise from its solution. Formulæ for two- and three-solution developers are given below:—

Two-solution

A. Metol	40 grs.	4.6 g.
Sodium sulphite	120 "	14 "
Potassium bromide	10 "	1.2 "
Hydroquinone	50 "	6 "
Water	20 oz.	1,000 ccs.
B. Potassium hydrate	40 grs.	4.6 g.
Water	20 oz.	1,000 ccs.

For use, take equal parts of each.

Three-solution

A. Metol	100 grs.	11.5 g.
Sodium sulphite	300 "	34.5 "
Water	20 oz.	1,000 ccs.
B. Hydroquinone	100 grs.	11.5 g.
Citric acid	25 "	3 "
Water	20 oz.	1,000 ccs.
C. Potass. carbonate	1 oz.	55 g.
Water	20 "	1,000 ccs.

Normally, use 1 part each of A and B and 2 parts of C; in cases of over-exposure, add potassium bromide, and for under-exposure increase the proportion of C.

When making up solutions of metol, sodium sulphite, and hydroquinone, always dissolve the chemicals in the order given.

METOL-SILVER INTENSIFIER

An intensifier specially suitable for wet or dry collodion negatives, either before or after fixing. Dr. Eder's formula is:—

A. Metol	72 grs.	16.5 g.
Citric acid	48 "	11 "
Water (distilled)	10 oz.	1,000 ccs.
B. Silver nitrate	48 grs.	11 g.
Water (distilled)	1 oz.	100 ccs.

The well-washed negative is dipped in A and then covered with a mixture of 10 parts of A and 1 part of B. Density increases rapidly. The opaque portions of the negative will appear blue by transmitted light when wet, and brown after drying.

METOL-SULPHITE

A commercial form of the metol developer to which alkali does not need to be added. For use, it is mixed with water. 1 oz. dissolved in 40 oz. of water makes a good stand developer.

METOQUINONE

Under this name Messrs. Lumière introduced into England, in 1903, a metol-hydroquinone developer, but in the same year the name was altered to "Quinomet" (*which see*). In other countries, metoquinone still refers to the Lumière preparation.

METOTYPE (Fr., *Métotype*; Ger., *Metotype*)

A paper or card coated with gold, silver, copper or bronze powder, beneath the sensitive emulsion, so that finished prints appear as if on a metallic surface. A similar result is obtained by coating ordinary stout gold or silver paper with celluloid varnish to isolate the metal, and allowing to dry thoroughly. Any P.O.P. emulsion may then be applied.

METRE

A metric measure of length equal to 39.370113 in. (about 39 $\frac{3}{8}$ in.).

METRIC SYSTEM (See "Weights and Measures.")**METZOGRAPH SCREEN**

A screen placed in front of the sensitive plate for breaking up the image into a grain in order to reproduce the image on a printing block, both screen and process being the invention of James Wheeler. In making the screen the surface of a sheet of plate glass is covered with a fine reticulated resinous grain as a result of burning pyrobutulin and holding the glass over the vapour. This grain forms a resist to hydrofluoric acid, so that the plate can be etched, after which the resinous grain is cleaned off and the granulations on the glass stand up in relief. Each grain point then acts as a tiny prism or lens deflecting the light and causing a grain effect to be imparted to the plate.

MEZZOCHROME

A process of intaglio printing in colours worked on the basis of the Rembrandt photogravure process.

MEZZO-RELIEVO

A term used principally in photo-sculpture. When the figures project in relief more than half their true proportions, the effect is termed alto-relievo; when exactly one-half the term used is mezzo-relievo; and if less than half, basso-relievo (English, bas-relief).

MEZZOTINTO

A process of colouring engravings, etc., and the prototype of the crystoleum process (*which see*).

MEZZOTINTO GRAVURE

A name given by Bruckmann, of Munich, to his process of rotary intaglio photogravure printing, which is supposed to be done after the style of the Rembrandt process.

MICA (Fr., *Mica*; Ger., *Glimmer*)

Various double silicates of alumina and alkalis, occurring naturally in blocks which split up into transparent sheets, each composed of laminae. Mica has been used as a support for gelatine emulsions, etc.

MICROMETRY

The measurement of minute divisions of space. The best known device for obtaining micrometrical measurements in microscopy and photomicrography is the stage micrometer ruled into lines to $\frac{1}{100}$ or $\frac{1}{1000}$ in., or $\frac{1}{10}$ and $\frac{1}{100}$ mm. A fairly accurate estimation of the size of an object can be made by focusing the ruled lines of this micrometer on the stage and carefully noting the space in the field taken up by a certain number of lines. The object to be measured is then substituted for the micrometer slip and focused with, of course, the same objective, eyepiece, and length of draw-tube. The approximate size of the object can then be gauged by comparing the diameter of the specimen with the space previously taken by the ruled lines. For accurate work a micrometer eyepiece is necessary to measure off the rulings of the stage micrometer. In the micrometer eyepiece a small plate of equidistant ruled lines is fixed in the focus of the eye lens of the eyepiece, the lines being then visible when the microscope is in use. The stage micrometer is focused in the usual way, and the number of its lines which take up the same space as a certain number of the eyepiece divisions is noted. The stage micrometer is then replaced by the specimen, and the diameter of the latter is compared with the previously noted eyepiece divisions. It is not necessary to have fixed numbers of lines per inch in the eyepiece rulings; in fact, two points in the focus of the eye lens are all that is required. Two small ink marks on a cover slip will answer the purpose. The cover slip is dropped on to the stop of the eyepiece and the number of rulings of the stage micrometer which fill the space between the ink spots noted; the size of the object can then be calculated.

For extreme accuracy the mechanical-screw eyepiece micrometer is necessary. In this eyepiece are two wires, one of which is fixed while the other, worked by a travelling screw turned by a milled head, traverses the field. Across the field is fixed a plate provided with minute teeth, and each revolution of the milled head moves the wire from one tooth to the next. By this means the stage rulings can be compared with the distance between the two wires with extreme accuracy.

In photomicrography the magnification of an object is easily found without the aid of a ruled eyepiece. The object is first focused on the ground glass of the camera, and its diameter marked by ink spots. The stage micrometer then replaces the object and, after focusing, the number of lines between the ink spots is read off. This gives the size of the object, and the magnification is then easily calculated by measuring the distance between the two ink marks.

MICROPHOTOGRAPHY

The production of photographs of microscopic size by means of the microscope. Microphotographs were at one time produced in large numbers for inserting into penholders, etc., but since the introduction of dry plates microphotography has become practically obsolete.

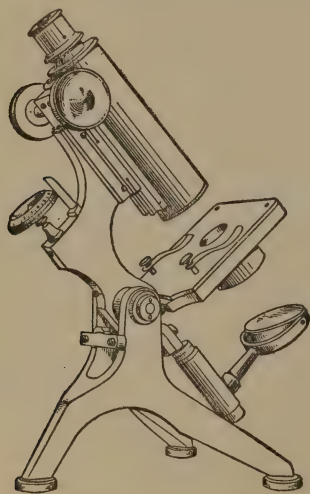
The wet collodion process is essential for this work owing to the structureless nature of the

collodion film, and the extremely fine grain of the silver deposit. An objective of 1 in. or $1\frac{1}{2}$ in. focal length is the most suitable lens. A camera is not required, as the prepared plate can be fixed to the microscope stage and exposed in that position. The operation must, of course, be carried on at night time, or in the dark-room. A clean, bright negative of the object is first made on an ordinary dry plate. The microscope, with the eyepiece removed and the objective in place, is put into a horizontal position, and the negative is placed at a distance of about 2 ft. from the lens. The open end of the microscope tube faces the negative. The most convenient arrangement for staging and illuminating the negative is a large box with one hole, slightly smaller than the negative, cut in the side, and another in the top, to serve as a chimney. The negative is secured in front of the hole by drawing-pins with a piece of ground glass or tissue paper behind it to diffuse the light. A lamp is placed behind the diffuser to illuminate the negative. The image of the negative given by the objective is now roughly focused on a piece of white card placed on the stage of the microscope, which is moved to and fro until the image is of the required size. The centre of a glass slip is coated with collodion and sensitised and transferred to the microscope stage. A sheet of cardboard is placed over the negative while the sensitised slip is being placed in position. The card is removed, and the image carefully refocused on the sensitised collodion, which makes an excellent focusing screen. As a small portion of the film will be fogged during focusing, before the exposure is made the card is replaced, and the slide moved slightly to replace the fogged part of the film by a fresh piece. Several trial exposures of varying length are made on different portions of the film, and the slide is then developed and fixed. Pyro and acetic acid should be used for development, as the deposit given by this reducer is of finer grain than that produced by an iron developer. The microphotograph, of course, requires the microscope or magnifying lens to resolve its details. The amount of reduction which the process will allow is limited by the size of the granules of the silver deposit, but the details of a half-plate negative are easily visible in a micro-photograph having as small a diameter as $\frac{1}{8}$ in.

MICROSCOPE (Fr., *Microscope*; Ger., *Mikroskop*)

The simple microscope, which was the earliest type of instrument, consists of a stand provided with a single lens or combination of lenses known as the objective, which is focused by mechanical means. This type of microscope is still used in laboratories for dissecting work. The compound microscope is fitted with an arrangement by which the image given by the objective is still further magnified by another lens or combination of lenses known as the eyepiece or ocular. A compound microscope is usually provided with a coarse and fine adjustment for focusing, the former being used for low magnifications and the latter for high magnifications. The illustration shows a typical instrument. The foot or base is usually of

either horseshoe or tripod form. The "limb" carries the focusing apparatus and the body-tube with objectives and eyepiece. The draw-tube, a smaller tube, sliding or moving by rack and pinion, inside the body-tube, receives the eyepiece or ocular, and enables the separation of objective and eyepiece to be varied at will. The draw-tube is also useful for objectives of very low power which require a longer working distance than the coarse adjustment will allow, the lower end of the tube being provided with a thread to receive the objective. The stage, which supports the object, is provided with clips to secure the glass slides, and is sometimes fitted with mechanical movements to enable the object under the lens to be accurately adjusted. The sub-stage condenser, for use with high powers, is fixed beneath the stage and focuses the light upon the object which is being examined. In the stage is an aperture in order



Compound Microscope

that transparent specimens may be illuminated by light reflected from the mirror beneath the stage. To facilitate the operation of changing the objective for one of another power, a swivel lens holder, known as a nosepiece, and allowing of the use of several objectives of various powers, can be screwed into the lower end of the microscope tube, and high or low power objectives can be brought into use by merely turning the nosepiece on the pivot. Most microscopes are inclinable; that is, the instrument can be brought over to a horizontal position for photomicrography.

MICROSCOPE, PHOTOGRAPHY WITH (See "Photomicrography.")

MICROSCOPE SLIDES FOR SPECIMENS

Glass slips measuring 3 in. by 1 in., on which sections intended for microscopic examination are mounted. Such objects and transparent sections are mounted in Canada balsam or glycerine. Opaque substances are mounted in cells. (See "Cells for Microscopical Specimens.")

MICROTOME

An instrument designed for cutting extremely thin sections of any tissue which is to be examined or photographed through the microscope. Two types of microtomes are used. One form merely holds, and pays out, the preparation, the actual cutting being done by hand. The other includes a razor which automatically cuts sections to the required thickness. Some kind of support is necessary to hold the material in the microtome. The method generally adopted is known as "imbedding"; the specimen is placed in melted paraffin wax till the tissues are permeated. The wax is allowed to set and, with the contained specimen, is then transferred to the microtome for cutting. The wax is subsequently dissolved from the tissues with turpentine. Another method of supporting the tissue is by placing the material to be cut in gum water on the stage of a microtome and freezing the mucilage by means of ether vapours.

MID-ANGLE LENS

A lens having a field of view of about 50°, or having a focal length equal to the longest side of the plate. The term is, however, very elastic.

MIDDLE ANGLE LENS (See "Mid-angle Lens.")

MIDDLE DISTANCE

That part of a picture intermediate between the foreground and the distance.

MILK PROCESS

Milk was one of the many substances used for preserving collodion plates. Twenty grains of condensed milk were mixed with each ounce of water, filtered, and flowed over the collodionised plate.

MILLIMETRE, MILLIGRAMME, MILLILITRE, ETC. (See "Weights and Measures.")

MINERAL PAPER

Synonym, papier minéral. A translucent paper which is pasted upon the glass side of negatives for the purpose of working upon in pencil or crayon.

MINES, PHOTOGRAPHY IN

With the advent of the dry plate, the modern lens and the actinic flash powders, photography in mines has become much more easy. The bunch of magnesium ribbon, lime-light apparatus and portable lamps have all been superseded. In gassy mines, the use of flashlight mixtures is inadmissible, but it answers well, for example, in the tin mines of Cornwall, which are deep, hot, smoky, wet and dirty, with grease, mud, and slime in abundance, in some places stagnant air in which the tallow candles will not burn, in others a draught so strong that naked candles cannot be kept alight. The hanging walls from which water drips from every jagged point of rock, the slippery footwalls, open stopes, deep gunnies, perpendicular ladders with iron staves, the low, narrow levels, etc., etc., present the most unpromising conditions for successful

photography. The miners work by the light of tallow candles stuck in a lump of clay which adheres to the hard hat they wear, or against the rock on arriving at the scene of their operations. These candles give out little illumination, but plenty of smoke. The angular rocks of a dull brown, non-actinic colour require powerful illuminants to bring out their structure. The mine photographer should be something of a mining engineer so as to grasp intelligently the idea which the photograph is intended to illustrate. In Cornwall he becomes familiar with mineral lodes and cross-courses, shafts, levels and winzes, air currents and ventilation. The principal features of mining, or the natural position of the miner at his work, must not be sacrificed in order to compose an artistic or sensational picture. Neither must he be fastidious about his dress, hands or apparatus, nor object to crawl on his hands and knees over the rough rocks, through narrow openings, and oftentimes dangerous places. The camera must be strong and well made, capable of enduring without serious damage the inevitable contact with points of rock. Double dark-slides filled with plates sufficient for the day's use should be taken. Plates could be changed underground as absolute darkness exists when the candles are extinguished, and it is quite easy to feel to do this work, but other conditions are not favourable to this course. It rarely happens that more than six plates can be exposed in one "shift," and as a rule only one exposure can be made in one place by reason of the smoke caused by the combustion of magnesium. At least three lenses are necessary, respectively of 10 in., 7 in., and 5 in. focal lengths. The greatest trouble with lenses is caused by moisture condensing on their cold surfaces, and in order to avoid this as much as possible they should be carried in the inner pocket of the flannel shirt next the skin. As soon as the cap is put on after focusing, condensation immediately covers the front of the lens, and this can scarcely be wondered at in a temperature exceeding 100° F. (about 38° C.), with steam rising from the water which runs at one's feet, or dropping from the jagged points of rock above the camera. A piece of soft silk kept in the trousers pocket should be used to wipe the lenses. In some places, where the heat is almost unbearable, drawers are the only garments worn by the miners at work.

In the past magnesium ribbon and the oxy-hydrogen light were used; now, after repeated experiments, triple flash lamps of great power have been found to give the best results. From two to four of these lamps are generally sufficient, with an exposure of about three or four seconds. By a judicious use of lamps some unique lighting effects can be obtained, but special attention must be given to air currents, which, if possible, should be upward, or else towards the camera. When it is not possible to photograph a gunnies (a large chamber) from one standpoint, it often answers to move the camera to the other end; this is probably due to the admission of good air at one end driving the foul air to the other, which, although not perceptible to the eye, is revealed by the lens and produces a foggy effect. Flash candles are useful when placed

behind a rock so as not to produce a glare in the lens.

The most sensitive plates are not the best for the purpose, because of their tendency to fog in forced development; there is usually more than enough of fog surrounding the object itself. A plate of medium speed, say 100 H. and D., backed, has been found to possess all the qualities necessary.

For photographing coal mines, the general arrangements are the same as in tin mining, but naked lights can only be used in those few collieries that are free from gas; otherwise, the difficulties are not so great, the mines are drier, the coal surfaces reflect the light, and very little trouble is experienced with coal dust.

In the slate mines of North Wales and other places, where there are vast excavated chambers a hundred fathoms from the surface, the conditions are easier still, the air is good, and it is a question only of sufficient lamps to light up the dark caverns.

The subsequent printing from the negative is a matter of ordinary practice, but the picture should represent as clearly as possible the colour of the rock or material photographed. By the carbon process, for instance, bluish tones representing slate can easily be obtained, or brown tints will depict the darker rocks in Cornish mines, and blue-black the coal deposits.

J. C. B.

MINIATURE (Fr., *Miniature*; Ger., *Miniatur*)

A term loosely applied to any small portrait. The best photographic miniatures are usually carbon prints of a suitable depth transferred to ivory and then coloured. The commoner forms of miniatures are prints upon ordinary P.O.P., coloured by means of aniline dyes.

MINIM

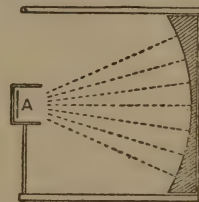
The one-sixtieth part of a dram, and the one-four hundred and eightieth part of an ounce. The idea that drops and minims are the same is erroneous, although when drops are mentioned minims are often meant. (See "Drops.")

MIRROR, BLACK (See "Black Mirror" and "Claude Lorraine Glass")

MIRROR BOX (See "Mirror, Reversing.")

MIRROR CAMERA (Fr., *Chambre miroir*; Ger., *Spiegelkamera*)

A camera devised by J. W. Draper in the early daguerreotype days, in which a large concave



Mirror Camera

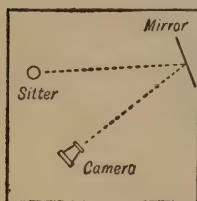
mirror was used instead of a lens, the plate A (see illustration) being placed in a small box facing the mirror, and receiving an image by

reflection. The advantage gained was the possibility of shorter exposures than were feasible with small aperture lenses, and the absence of chromatic aberration; but it is difficult to avoid a certain amount of stray light, and the mirror has to be large to compensate for the obstruction of illumination caused by the plate and its support.

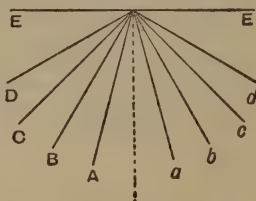
Concave mirrors are of value in stellar photography, where any stray light met with is but feeble.

MIRROR PHOTOGRAPHY

The art of photographing objects reflected in a mirror, enabling one at times to obtain photographs which would otherwise be impossible owing to confined space or the use of a long focus lens. For example, and as shown at A, in a small room and using a long focus lens, the only way of photographing a sitter would be to place a mirror at a suitable angle opposite the sitter, and to arrange the camera so as to photograph the reflection. In convenience, the distance of camera from sitter is doubled, whereas in fact the camera is nearer the model but pointing in another direction, namely, that of the mirror. The law of regular reflection is that the angle of reflection is equal to the angle of incidence, as can be proved by a minute's experimenting. A mirror placed as shown at B would reflect D at *d*, C at *c*, B at *b*, and so on. D is at the same angle with E E as is *d*, and the



A. Arrangement for Mirror Photography



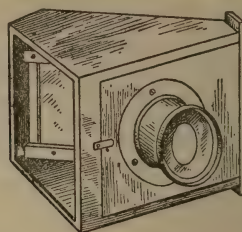
B. Diagram showing Principle of Mirror Photography

same holds good with regard to C and *c* and B and *b*. Therefore, to photograph an object at, say, C, the camera should be placed on the line *c*, but not necessarily at the same distance from the mirror as the object photographed. Much depends upon the size of the mirror. As is well known, a mirror reverses the objects as regards left and right, and therefore to secure a correct image in the print the negative must be reversed, either by stripping the film or by inserting the plate into the dark-slide glass surface outwards, care being taken that the glass is perfectly clean.

MIRROR, REVERSING (Fr., *Miroir de renversement*; Ger., *Umkehrspiegel*)

A surface-silvered plane mirror is frequently used, at an angle of 45° , in front of or behind the lens when reversed negatives are required. Behind the lens is the best position, as the mirror is then better protected from air and dust, and one lens can be changed for another without disturbing the mirror. The mirror is usually enclosed in a box, as illustrated, the open side fitting on the camera front and the lens

being placed at the side of the box, at a right-angle with the focusing screen or plate. The



Mirror Box

copy or object is arranged sideways to the camera. (See also "Prism.")

MIRRORS, DISTORTING

The use of distorting mirrors is described under the headings "Anamorphoscope" and "Caricature."

MISCHEWSKI'S REDUCER

A cerium reducer introduced in 1900, and consisting of a solution of 1 oz. of cerium sulphite and 3 drms. of sulphuric acid in 10 oz. of water; to be kept in the dark. One part of this stock solution is diluted with 3 parts of water for use. It works rapidly, and does not alter the colour of the negative.

MIXTOL

A "mixed" developer of Continental origin (1892), and containing hydroquinone and eikonogen as the developing agents proper. (For formula, see "Developers, Mixed.")

MODELLING

A term used to indicate that the play of light and shade has been so rendered as to suggest accurately the contours and surfaces of the subject.

MODELS (Fr., *Modèles*; Ger., *Modelle*)

The professional artist's model frequently has objections to posing for the photographer, especially if the photographs are intended to be reproduced commercially in large numbers, for which purpose the model's permission in writing should always be secured, even when the photographer undoubtedly owns the copyright of the pictures in which the model is shown. A professional model, whose especial business is to pose, will thoroughly enter into the spirit of the business and will frequently, as the result of experience, be able to offer valuable suggestions. The amateur model is often somewhat prone to look camera-conscious. There has been a general feeling that actors make but poor models, but the development of the art of cinematography has brought into being a special class of motion picture actors who, generally speaking, are excellent in every way.

MOGUL VARNISH

A waterproof and acid-resisting varnish of American origin, used by process workers. It is believed to be a bituminous by-product from petroleum wells, and is dissolved or thinned

with coal-tar naphtha. Spread on glass and etched through with a needle-point, it is the means of making excellent lantern slides of diagrams, etc. It may be used for coating trays of wood, metal, or cardboard for developing and other purposes.

MOISTURE (See "Damp, Precautions against.")

MOLECULAR DISTURBANCE AND STRAIN THEORY (See "Latent Image.")

MOLYBDENUM PRINTING

Several of the molybdenum salts, such as the chloride and ammonium molybdate, are sensitive to light, and give faint images, usually of a bluish tinge, which can be developed or toned to various colours with ferricyanide, chloride of gold, etc. The processes are, however, of purely theoretical interest.

MONCKHOVEN'S INTENSIFIER

An intensifier by means of which the image is bleached with mercury and blackened with a solution of silver nitrate and potassium cyanide. It intensifies the lights to a greater extent than the shadows, and is best suited to an over-exposed and under-developed negative. The formula is:—

A. Mercuric chloride	10 grs.	2 g.
Potass. bromide .	10 "	2 "
Water .	1 oz.	100 ccs.
B. Silver nitrate .	10 grs.	2 g.
Potass. cyanide		
(about) .	10 "	2 "
Water (distilled) .	1 oz.	100 ccs.

In making up B the water should be halved and the cyanide dissolved in one half and the silver in the other. The cyanide is then poured into the silver solution and the mixture shaken. A white precipitate will be formed, and will gradually become almost but not wholly dissolved. If it should be quite dissolved, add a drop or so of silver nitrate solution until a slight precipitate remains. The mixture is next filtered, or the clear portion (actually somewhat discoloured) poured off for use. The negative is immersed in A until bleached, washed for about fifteen minutes, blackened in B, and finally washed. The process may be repeated if necessary, but the negative must not be left in the cyanide-silver mixture too long, or a gradual reduction will take place. The colour of the intensified image is a good black or brown black, no matter what the original colour may have been.

MONO-CARBOXYLIC ACIDS (See "Carboxylic Acids.")

MONOCHROMATIC LIGHT

Literally, this means a light of the colour of one ray of the spectrum, but in the general sense it is applied to light of one colour, though this may comprise a fairly wide band in the spectrum. It has been very usual to speak of the monochromatic sodium light, though this actually comprises several blue and violet rays as well as the two familiar D lines in the orange

yellow. It is possible to obtain pure monochromatic light by isolating one individual Fraunhofer line in the spectrum of a metal or gas, such as thallium, which gives a single isolated line at λ 5348, or the hydrogen F line λ 4861. These lines may be isolated either by means of a prismatic spectrum and metal screens so pierced as to allow only the one ray to pass, or by colour filters which absorb all but a narrow band in the spectrum coincident with the line in question.

MONOCHROMATIC SCREEN

A term applied to colour filters usually prepared with aniline dyes so that they pass light of one colour, but not strictly monochromatic if reference is made to the spectrum. As a rule, such screens pass a band comprising about ten wave-lengths, but the eye is not sufficiently sensitive to distinguish them, and they, therefore, appear monochromatic, or of one colour. They are used in photomicrography, and for special spectroscopic and astronomical work.

MONOCHROME (Fr., *Monochrome*; Ger., *Einfarbige Gemälde*)

Literally, one tint or colour. Practically all photographs are in monochrome; that is to say, the image is black, brown, red, green, etc., according to the process employed. The exceptions are prints made by the three-colour processes, by multiple gum printing, or by the oil-pigment process. Photographs in colour on glass plates are, of course, in a different category.

MONOCHROME, RENDERING COLOURS IN

The ordinary photograph is limited in the sense that the various colours of the original are all recorded by different shades of grey or monochrome. Should a yellow daffodil be placed in front of a violet screen, the yellow of the flower and the violet of the screen both being equally bright, the eye would at once differentiate them owing to the colour contrast. A fully iso- or ortho-chromatic plate would record them in the negative as of exactly equal tone. An ordinary plate would render the violet screen almost white, the yellow daffodil almost black. Both results would be wrong.

The ordinary photograph is all of one colour, hence the rendering is in monochrome, and we are dependent on monochrome contrasts to represent both light and shade, and colour contrasts. How a correct rendering in monochrome of a coloured subject can be effected will be seen by a reference to a plate accompanying this work: "Various Renderings of Daffodils in a Blue Vase." The left-hand top picture shows an absolutely incorrect rendering, as is inevitable when using an ordinary plate which is practically insensitive to yellow, hence the flowers appear nearly black. The blue of the vase is intensely actinic, and in consequence appears white. In the top right-hand picture is shown the same subject recorded orthochromatically, the vase appearing dark and the flowers light grey. By slightly overdoing the colour correction a picture is obtained (bottom right-hand figure)

which gives an excellent contrast between flowers and vase. It will thus be seen that by intentional wrong rendering in monochrome it is possible to suggest to the eye the colour contrasts that it would see in the original subject.

In the spectrum, the brightest colour, to the eye, is the greenish-yellow; apple green and orange are the next brightest; blue-green and orange-red less bright; and violet and ruby least bright. When a perfectly correct colour rendering is required, the plate and the screen must be so combined that on photographing the spectrum the various pure colours would be recorded in monochrome in the order given, greenish-yellow (lightest), green and orange, blue and red, violet and ruby.

The monochrome gradation is again altered according to the colour of the print. An ordinary subject, such as a cottage or house, appears very "flat" in a yellow carbon print, and much brighter or more contrasty if printed in pink, green or blue. The tone values in each print, relatively to each other, would be the same, but the apparent contrasts to the eye would vary greatly. Where subtle contrasts require emphasis, a warm colour such as sepia should not be employed for the print, but either a bright grey, such as would be given by a gaslight print, or a blue tone.

MONOCLE (Fr., *Monocle*; Ger., *Monokel*)

A single or "spectacle" lens used as an adjunct to an ordinary lens, either to lengthen or shorten its focal length, or to serve as a telephoto attachment.

Also a graphoscope for viewing pictures, the lens being too small to allow both eyes to be used.

MONOCULAR (Fr., *Monoculaire*; Ger., *Einäugig*)

Literally, one-eyed. Monocular vision is vision with one eye, as distinct from binocular vision, which is vision with two eyes. (See also "Stereoscopic Photography.")

MONOL

A trade developer containing a dark red aniline or other colouring matter allowing of plates being developed therein in daylight.

MONOMETHYLPARAMIDOPHENOL

The original name for what is now known as metol (*which see*).

MONUMENTAL WORK, PHOTOGRAPHING

The difficulty in this branch of photography is common to all subjects that are either uniformly light or uniformly dark in colour. Sunshine is not desirable; it is rarely successful in small subjects photographed from a near point of view; and there is a risk of an entire absence of good light and shade if too uniform a lighting be adopted. The best results will be obtained by selecting a time of day when the principal side is in strong light, and then making the exposure while the sun is temporarily obscured by a light cloud. (See also "Sculpture, Photographing.")

MOON, PHOTOGRAPHING THE (Fr. *Photographie de la lune*; Ger., *Mondphotographie*)

The photographer who wishes to apply his art to astronomical matters cannot do better than begin with the portrayal of the features of the moon, which, as is well known, is our nearest celestial neighbour. Creditable work may be done with the ordinary hand or stand camera, but it will be understood that with lenses of short focal length it is impossible to obtain images of the exquisite detail which is known to be present on the moon's surface. To obtain such images, a large equivalent focal length is indispensable, but it is immaterial whether this is attained by a long-focus objective or by a telephoto combination. Excellent images showing all the main features of the craters, etc., may be taken with an equivalent focal length of about 10 ft., giving an image of the moon about 1 in. in diameter. Many of the standard photographs obtained for charting purposes, however, have been taken with equivalent focal lengths of as much as 300 ft. For minute study, enlargements can, of course, be employed, but they have the disadvantage of showing up the grain of the original negative, so that if a large scale picture is desired, it is best to use an amplifying lens in the camera. The first successful photographs of the moon were made by Rutherford. Later pictures have been produced by Common, Barnard at the Lick Observatory, Ritchey at the Yerkes Observatory, and Loewy and Puiseux at Paris.

Except when working with instruments of very large aperture, rapid plates should be employed, so that the minimum exposure may be given, thereby minimising the risk of failure on account of movement of the image. Backed plates are essential. The range of contrast between the bright limb and the craters near the moon's terminator is considerable, and development should be so arranged that the gradation is kept without having to force out detail. As the exposures will, in general, be of minimum duration, a soft developer will be most likely to give greatest satisfaction.

Quite recently, a new field of research on the moon has been opened by the discovery by R. W. Wood that certain regions of the lunar surface exercise considerable selective absorption. This is especially noticeable when the photographs are taken through screens which only pass ultra-violet light. If a quartz lens is coated with a very thin film of pure silver, it will allow the ultra-violet components of light to pass uninterrupted, but all the visible light rays will be absorbed. Under such circumstances he has found that certain portions of the moon's surface appear darker than when photographed in ordinary white light, and thus it may be inferred that such parts of the moon are composed of some substance which absorbs ultra-violet radiations.

MOONLIGHT EFFECTS

Real moonlight views are possible in very favourable circumstances, but most of the so-called moonlight photographs are taken in daylight, the usual method employed being to take the photograph with the sun facing the

lens, but not included in the view. A cloudy day should be chosen and the exposure made when the sun is just disappearing behind a cloud, or re-appearing therefrom. Should the sun be included it will appear as a reversed (black) spot and the plate will probably be fogged. A very brief exposure should be given (the plate must, in fact, be under-exposed) and the developer should be restrained with potassium bromide in order to give great density to the bright edges of the clouds and other high lights, without permitting detail to be over-pronounced in the shadows. The object is to emphasise the high lights, more particularly those in the sky and at other reflecting points.

The task of photographing a view illuminated by moonlight is not difficult if long enough exposure is given, but it is not easy to include the moon itself. The fastest of isochromatic plates, backed, should be used. As a rule, the best time is one or two evenings before the moon is full, as it then rises early enough to allow of the photographer making use of the diffused light of the after-glow to shorten the exposure, and if the moon is to be included the slight flattening of the disc will be hardly noticeable. In marine work, in harbours, or tidal rivers, where vessels are shown at a wharf or the water-line along a flat shore is included (such subjects and winter scenes make the best pictures), it is better, if possible, to make the exposure either at full or low tide, as then objects will not be blurred by a change of water level during exposure. An average subject, using $f/8$ and a rapid isochromatic plate, will need from ten to thirty minutes' exposure on a clear night. Do not under-expose; rather give double or even treble the exposures named.

W. S. Davis, of the United States, advocates two ways in which the moon may be included in the photograph without showing movement. One method is to wait until the moon is high enough to be out of the field of view included by the lens; focus and expose for the foreground as usual, remove the plate, then tilt the camera and raise the front until the moon comes where it is wanted in the composition, replace the plate and give a short exposure for the moon itself—from ten to thirty seconds will be ample with the lens at full aperture. The moon and the foreground are thus obtained upon one plate. For early moonrise effects, W. S. Davis exposes a separate plate on the moon, and puts it at the back of the foreground when printing. The first-named method is to be preferred, but care must be taken to locate the moon exactly where it is wanted. To do this properly take some gummed black paper and, before moving the camera for the second part of the exposure, decide upon the spot on the focusing screen it is to occupy, and attach a piece of gummed paper, in which a small hole has been made, so that when arranging for the exposure for the moon, the latter can be seen through the opening.

If wide-angle or medium-angle lenses are used, the image of the moon in the photograph will not appear so large, in proportion, as it does to the eye, and for this reason it is often

advisable to use a longer focus lens for the moon than for the rest of the view; otherwise the moon may be made to appear larger by having it a little out of focus.

Moonlight photographs are usually printed on sea-green or blue carbon, or bromide prints are made and then toned to those colours. Prints on P.O.P. may be stained by means of an aniline dye.

MORENO'S DEVELOPER

A pyro-soda developer which aroused considerable interest in 1894, when it was published in America. Moreno advocated the use of saturated solutions, with which he developed batch after batch of plates in the same bath; on one occasion, it is said, he developed 100 half-plates in 16 oz. of solution. Two pint bottles are filled respectively with saturated solutions of sodium carbonate and sodium sulphite; in a third, say a 5 oz. bottle, is placed 4 oz. of the sulphite solution, and to this is added pyrogalllic acid so long as it dissolves readily—in most cases 1 oz. will be the correct quantity. The three stock solutions may be thus represented in the orthodox way:—

A. Sodium sulphite (saturated solution.)		
B. Sodium carbonate	"	"
C. Solution A	4 oz.	100 ccs.
Pyrogalllic acid	1 "	25 "

To make up a developer ready for use, mix together 1 oz. of A, $\frac{1}{2}$ oz. of B, and $\frac{1}{4}$ oz. of C; do not add water.

MORPHIA PROCESS

An old dry collodion process. The plate was sensitised with bromo-iodised collodion, washed and placed in acetate of morphia 15 grs., water 17 oz. Having been dried, it was exposed twice as long as a wet plate, and developed with pyrogalllic acid.

MOSSTYPE (Fr., *Mosstype*; Ger., *Mossdruck*)

A method of making half-tone blocks invented by J. C. Moss, of New York. Plate glass was coated with bichromated gelatine, dried, exposed under a dense half-tone negative and soaked in water, which was absorbed only by the parts that had been protected from light, these swelling and forming a half-tone relief. From this was taken a plaster or wax cast, and from the cast a plaster mould, which was used to make a stereotype.

MOTAY'S COLLOTYPE PROCESS (See "Maréchal's Collotype Process.")

MOTIF

This French form of the word motive is generally used to denote the idea, phase, or particular presentment which the photographer intended to convey by his picture.

MOTION (See "Action.")

MOTION PICTURES (See "Chrono-photography" and "Kinematography.")

MOTIONAL PERSPECTIVE (See "Stereoscopic Photography.")

MOTTLING

A defect seen occasionally upon the dense portions of a negative. Unless the developer is kept moving in a gentle wave backwards and forwards over the plate mottling is almost sure to occur.

MOULDING (Fr., *Moulure*; Ger., *Kehlung*)

This is the name given to lengths of wood used for making into frames. Such mouldings are generally sold with the wood in its natural state; that is, neither stained nor polished. Some mouldings are faced with composition—a kind of hard plaster—and these, of course, are sold in their finished state; there is some danger of this surface chipping. In selecting wood mouldings for photograph frames, it is generally wise to confine the choice to the simpler patterns, rather than those that are elaborate or ornate. The wood should be sound and well-seasoned, and the mouldings sharply cut, without roughness or irregularity. (See also "Frame" and "Framing.")

MOUNT (Fr., *Monture*; Ger., *Einrahmung*, *Einfassung*)

Mounts may be broadly classified as paste-on or slip-in, and both kinds may be obtained commercially in large variety; although some patterns are everything that a photographic mount should not be, there are many that are quite tasteful and suitable. The serious objection to any ready-made mount is that it necessitates the dimensions of the print being kept to one of the standard sizes. As the great majority of properly trimmed prints vary more or less from any stock size, it is advisable to resort very frequently to a mount specially made. Fortunately, excellent papers and boards for this purpose are readily obtainable, and it is well to have these in reserve for use when the ready-made mount is not quite satisfactory. Both trade mounts and mounting papers should be of good quality, and specially prepared for photographic purposes, so that they may be free from anything deleterious to the print.

Oxford line, plate-sunk, India-tint, circular and oval mounts are all made in endless variety, as are also the usual stock mounts for carte-de-visite, cabinet, and other standard sizes for portrait work. There are also embossed and fancy mounts, with and without inscriptions. All of these have their uses; but, as in the case of frames, it is necessary to bear in mind that the print itself is the thing, and that its surroundings should be such as to display it to the best advantage, and neither to minimise its effect nor distract attention from it. (See also "Multiple Mounting.")

MOUNTANTS (Fr., *Colles*; Ger., *Kleisters*)

The adhesive by means of which a print is attached to its mount. Of the very many mountants available, starch is by far the most widely used, yet it keeps badly and is unsuitable for glazed prints. A glazed P.O.P. print mounted with plain starch may lose its glaze and show markings, whereas if an alcoholic solution were used the print would be unaffected.

Arrowroot.—This is an excellent mountant when a little gelatine is added:—

Bermuda arrowroot	2 oz.	122 g.
Gelatine . . .	90 grs.	11.5 "
Water . . .	18 oz.	1,000 ccs.

Soak the gelatine in some of the water for an hour or two, and melt by heat. Mix the arrowroot into a cream with a little water, and add to the gelatine, stirring all the time. Boil the whole in an enamelled saucepan or in a water-bath till a clear jelly forms, and add slowly 2 oz. of methylated spirit and 6 drops of carbolic acid. Allow to cool, and keep as airtight as possible.

Dextrine.—This is a good mountant of a white, creamy character; it keeps well. A formula is:—

Best white dextrine	25 oz.	900 g.
Alum . . .	1 "	36 "
Sugar . . .	4 "	144 "
Water . . .	30 "	1,000 ccs.
Carbolic acid (10 %)	1½ "	54 g.

Mix the dextrine with the water, boil for five minutes, add the sugar and the acid, and finally the alum dissolved in about 2 oz. of hot water. The alum may be left out if desired, as it may injure some prints, particularly those on collodion-chloride paper. Inferior dextrine is likely to remain sticky and not dry properly.

Another and a more simple dextrine formula which will meet all requirements is to rub up 1 lb. of best white dextrine with enough cold water to make a stiff paste and add 10 oz. of water, and 60 drops of oil of winter-green. Bring the whole to a boil, when it should be like clear gum. Pour into pots or jars, and in about twenty-four hours it should set in the form of a good white creamy paste. Use cold.

Dextrine and Gum.—This has no advantages over dextrine alone. The best formula is:—

Gum arabic (best white) . . .	½ oz.	70 g.
Dextrine . . .	2¼ "	315 "
Liquor ammoniæ . . .	2 mins.	5 ccs.
Carbolic acid . . .	60 "	15 "
Water . . .	8 oz.	1,000 "

Powder the gum and mix thoroughly with the dry dextrine, and rub up with 2 oz. of the water to make a smooth paste. Add the remaining 6 oz. of water and boil for ten minutes; when cool, stir in the ammonia and carbolic acid. This will keep for months.

Gelatine.—Most gelatine mountants have to be heated before use. A standard formula is:—

Gelatine . . .	1 oz.	110 g.
Glycerine . . .	½ "	50 ccs.
Alcohol . . .	1½ "	150 "
Carbolic acid . . .	20 mins.	4 "
Water (about) . . .	1 oz.	100 "

Cover the gelatine with the cold water and allow to soak for twenty hours or more. Pour off any excess of water, place the gelatine in a jar stood in a saucepan, and heat till melted; then add the glycerine, alcohol and acid with constant stirring. If too stiff, add water.

A liquid gelatine mountant, and one always ready for use, is made by soaking 1 oz. of gelatine in 3 oz. of water for twenty-four hours, melting by heat, and adding ½ oz. of chloral hydrate, afterwards heating for half an hour and adding sufficient washing soda to render the gelatine mixture neutral to litmus.

Gum.—Ordinary office and commercial mixtures of gum are likely to cause fading because of the chemicals used to preserve such mixtures. A suitable formula for a photographic mountant is:—

Best gum arabic .	5 oz.	275 g.
Glycerine .	1½ "	69 "
Alcohol .	4 "	220 "
Water .	12-20 "	600-1,000 ccs.

Dissolve the gum in the water, add the glycerine and finally the alcohol.

Indiarubber.—Indiarubber solution (see "Indiarubber") is useful for mounting glazed and dried prints without cockling. Cut a piece of paper ¼ in. smaller than the print in both dimensions, place it centrally upon the back of the dry print, coat the exposed margin with the solution, remove the paper, and press the print down on the mount. In course of time, the rubber perishes and the print leaves the mount.

Shellac.—A good shellac mountant is made by mixing 4 parts of shellac with 1 part of mastic, powdered, and dissolving in from 10 to 15 parts of spirit of wine. It must be put in a warm place, and after a few days the gums will be dissolved. If too thick, add more alcohol. The print must be quite dry, and the back brushed over with the mountant, immediately placed on the mount, and allowed to dry. A thin print can be thus mounted without cockling.

Starch.—Rub up 1 part of good white starch with 2 or 3 parts of cold water into a perfectly smooth cream-like paste, and then with constant stirring pour this into from 6 to 8 parts of boiling water and continue the heat for five minutes, stirring constantly. Allow to cool, and if not free from lumps squeeze it through muslin. Another plan is to rub the starch into a paste, as above, and to pour boiling water upon it, stirring constantly until it jellifies. All starch mountants should be allowed to cool and the top skin be taken off before use. Such pastes keep good for two or three days only, but the addition of a few drops of oil of cloves or carbolic acid will preserve them for a longer period.

Starch and Gelatine.—This is a stiff, smooth paste which does not cause cockling when properly applied. Take 2 parts of wheat starch and 1 part of rice starch, and mix thoroughly. Soak 60 grs. of gelatine in 10 oz. of water and heat till dissolved. When the latter has cooled to about 70° F. (21° C.), add the mixed starches in small quantities, stirring all the time until the mixture is of the consistency of thin cream. Heat slowly, in a jar placed in a saucepan of water, until the starch thickens; and continue the heat until about one-fifth of the water has evaporated. Then add slowly, with constant stirring, 1 oz. of alcohol and about 45 drops of oil of cloves.

Starch and Gum.—A suitable formula is:—

Gum arabic .	1 oz.	100 g.
Rice starch .	1 "	100 "
White sugar .	4 "	400 "
Water .	q.s.	q.s.

Dissolve the gum in as small a quantity of water as possible, add the sugar, stir in the

starch, which has been rubbed up into a cream with water, and boil the mixture until the starch is jellified.

Adhesive Prints and Mounts.—Adhesive mounts are made by spreading a thick solution of gum tragacanth upon them and allowing to dry. When the damp print is pressed into contact with the gummed surface, there is immediate adhesion. Similarly, glazed prints, while still on the glass or ferrotype plate, may be coated with:—

A. Bleached shellac .	2 oz.	200 g.
Alcohol .	4 "	400 ccs.
B. Borax .	24 grs.	5 g.
Curd soap powder	24 "	5 "
Water .	100 mins.	20 ccs.

Allow A to stand for a week and agitate frequently; then add B, thoroughly shake, and use the clear part, or filter. After the prints have been coated and allowed to dry, they are stripped from the support, pressed into contact with the mount, and attached by passing a hot iron over them, interposing a piece of blotting-paper between iron and print.

MOUNTING (Fr., *Montage*; Ger., *Einfassung*)

There are many ways of sticking down a print smoothly on a support or mount, but all of them are not necessarily suitable in the case of photographs, where the image is often of such a character as to be readily and seriously affected by substances harmful to it. For example, glue, gum, and paste, that may be proper for certain uses, may have disastrous effects when used as photographic mountants.

In the case of glazed prints, whose surface would be affected by moisture, indiarubber solution is sometimes used. Gelatine, which had to be warmed for use, was once fairly popular. The favourite professional mountant was, and to some extent still is, starch paste. If this is used it should be made freshly every day and used cold. The prints are generally mounted while still wet, the starch being applied to the back, the print placed in position and rubbed down, and the surface gone over with a wet sponge. This is a clean and effective method of mounting, but there is the serious drawback that the contraction of the print on drying warps or curls the mount considerably unless precautions are taken against it, and such precautions mean additional time and trouble.

Specially prepared mountants can be obtained that not only contain very little moisture, but will keep in good condition for a long time. If such a mountant is used with dry prints the risk of cockling and warping is reduced to a minimum. The mountant should be well rubbed over the back of the print with a stiff brush, using as little of the paste as can be made to cover the surface perfectly. If the print is then applied quickly to its position (previously marked) on the mount, it can be at once brought into perfect contact by the use of a roller squeegee. With care there should be no trace of mountant on the face of the print, especially if a sheet of thin paper be placed over it to protect it from possible traces of paste on the roller. This method of mounting is probably the best for the beginner, especially

as the mountant is always ready when an occasional print has to be dealt with. When large prints are being treated it is generally advisable to thin the paste very slightly by dipping the brush into water before rubbing up the paste with it, but for small prints simple rubbing up with the brush is sufficient.

Another method of mounting photographs, and one which has distinct advantages, is "dry mounting" (*which see*). Multiple mounting is described under its own heading.

In *process work*, the term "mounting" is also applied to fixing the etched zinc or copper plates on to a wood or other mount for the purpose of bringing the plates up to type-height. It also applies to the various operations of trimming and squaring up the plate or block. In America the equivalent term is "blocking."

MOUNTS, LENS

Photographic lenses are usually mounted in brass, but in certain cases, especially with telephoto combinations, the lighter metals, aluminium or magnalium, may be used. The iris diaphragm should be made of metal, especially in a lens for use in an enlarging lantern, as the heat is liable to distort, and even to destroy, iris leaves constructed of vulcanite or ebonite. Lenses should always be fitted with the standard threads of the Royal Photographic Society, and in the case of Continental makes it is convenient to have a fixed adapter made to the next larger standard thread. The lens hood may be considered a part of the mount; unfortunately, it has now fallen into disuse, but in these days of large apertures and rapid plates it is more than ever necessary; however, it is obtainable as a separate accessory, which may be made to serve for several lenses.

The following are the measurements and standards recommended by the Royal Photographic Society. The recommendations are:—

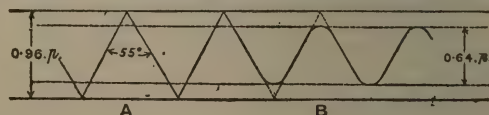
(1) That the equivalent focal length of a lens be engraved upon its mount.

(2) That the following series of screws for photographic lens flange fittings be adopted, it being understood that, in order to secure free interchangeability, every male screw should be made at least as small as these sizes and every female screw at least as large:—

Diameter in inches.	No. of threads per inch.	Core diameter in inches.
1*	24	.9466
1.25	24	1.1966
1.375	24	1.3216
1.5	24	1.4466
1.625	24	1.5716
1.75	24	1.6966
1.875	24	1.8216
2	24	1.9466
2.25	24	2.1966
2.5	24	2.4466
3	24	2.9466
3.5	12	3.3933
4	12	3.8933
5	12	4.8933
And upwards, advancing by inches	12	

* For screws less than 1 inch in diameter, the Royal Microscopical Society's Standard screw should be adopted.

The form of thread is that known as Whitworth's angular thread, and is designed as follows:—Two parallel lines, at a distance apart equal to .96 of the screw pitch, are intersected by lines inclined to each other at fifty-five degrees, as shown in the figure at A. One-sixth of the vertical height of the triangular spaces so obtained is rounded off both at the top and bottom, leaving the form of the screw thread as at B. The depth of this thread is .64 of the screw pitch. This is the theoretical form of the Whitworth thread, but for the purpose of securing real interchangeability it is



Whitworth's Angular Thread for Lens Mounts

generally found necessary to use chasers or other threading tools which have additional prominence upon those points which come first into operation and are subject to most wear. For this purpose an addition may be made to the amount of one-tenth ($\frac{1}{10}$) of the theoretical depth of thread or to any less amount that may be sufficient.

(3) That every flange and adapter have a mark upon its front to indicate the position of the diaphragm slot or index of any lens when screwed home. The mark on any adapter should coincide with the mark upon any flange into which it is screwed. This mark should be placed at the point at which the thread becomes complete at the shoulder of the flange or adapter.

"M.Q."

The meto-hydroquinone developer (*which see*) "M" indicating metol, and "Q" hydroquinone (quinol).

MUCILAGE (See "Mountants.")

MULTI-COLOUR OR MULTIPLE GUM PRINTING

An elaborate and somewhat complicated form of gum-bichromate printing. It consists in coating paper with the sensitive pigment, printing and developing, and then, when dry, re-coating, printing, and developing again, repeating the process as many times as is considered necessary. In this way the image is built up and parts brought out more prominently. It is a common practice not to recoat with the pigment used the first time on the paper, but to use a different colour for each coating and so obtain a print in colours. Lighter colours are used at first and the shadows built up with deeper colours. By varying the thickness of coating and depth of printing, masking during printing, and developing with a brush, highly effective results become possible. Considerable practice and artistic skill are required to produce a satisfactory print. One of the greatest difficulties is in registering the various printings; some workers prefer stout card to paper, as the registering is easier, while others use special frames. The process opens up a wide field for the display of individuality.

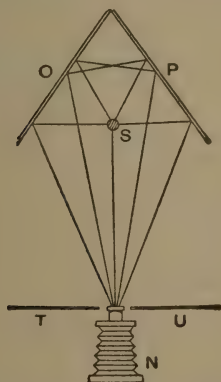
MULTIPLE MOUNTING

In the simplest form of this style of mounting a trimmed print is mounted on a sheet of paper, which is then trimmed so as to show a narrow margin all round the print. This in its turn is mounted on another sheet of paper, preferably already laid down on a piece of stout board. The margins then being measured off and trimmed, the print will be found to be effectively mounted, provided the mounting papers harmonise with each other and with the print. There is the obvious advantage that the mount is made to fit the print, and not the print trimmed to fit the mount, as in the case of ready-made mounts.

A simple and effective mounting may be secured by laying down a warm print on a brown paper, which may be called No. 1, and trimming to show a fairly wide edge. This is now laid down on another sheet, No. 2, either lighter or darker than No. 1, and trimmed to give a narrow edge. The whole is then finally mounted on a sheet of No. 1. A few experiments of this kind will soon give an idea of the wide possibilities of this style of mounting when it is carried out with restraint and good taste. When several sheets of paper are superimposed it is frequently the practice to attach them by their top edges only, but as it is then impossible to keep all the sheets in perfect contact, there is an inevitable irregularity in the various margins that considerably detracts from the beauty of the result. A good stock of suitable papers is required for the work, together with facilities for accurate trimming and perfect mounting. The "passe-partout" style of framing is often the most suitable finish for this class of mounting, but if a frame is used the moulding should generally be very narrow and simple.

MULTIPLE PHOTOGRAPHY (Fr., *La photographie multiple*; Ger., *Vielfachphotographie*)

Under this heading are included many methods whereby a number of photographs, whether alike or in different positions, are obtained on a single



Arrangement for Multiple Photography

plate. A number of similar photographs may be made at once by means of a camera with a battery of lenses (see "Postage Stamp Photo-

graphs"), or in succession with a repeating back. A method at one time popular in America, and still used in France for photographing criminals, is to place the sitter in front of two large upright mirrors joining at an angle of 72° , the result being that five different positions are secured. The camera is set in line with the junction of the mirrors, a screen being adjusted at each side of the lens to prevent reflections from objects behind the operator. The arrangement of the apparatus, and the method in which the multiple reflections are formed, is shown in the diagram, N being the camera, O P the mirrors, S the sitter, and T U the screens. With sufficiently long mirrors, full-length photographs are obtainable.

MULTIPLE-COATED PLATES

Plates coated with two or more layers of emulsion of different degrees of sensitiveness, introduced in 1891, to prevent halation. The topmost film was a rapid emulsion, the second of medium sensitiveness and more opaque, whilst the third was a lantern emulsion of very slow speed and very opaque, so that on exposure in a camera the light from a brilliantly-lit object would penetrate the first and second films and possibly partly through the third, but would not reach right through to the back of the glass, so that it could not be thence reflected to give rise to halation. The shadows and less brilliantly illuminated parts would be recorded on the top and second films only.

MURIATES (See "Chlorides," "Ammonium Chloride," "Mercuric Chloride," etc.)

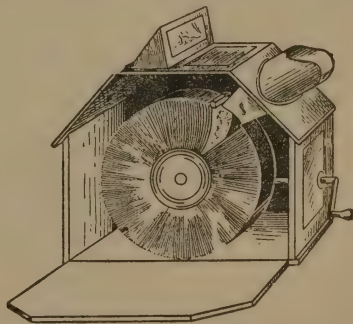
MURIATIC ACID (See "Hydrochloric Acid.")

MUTOGRAPH

Casler's camera for obtaining pictures for his biograph (*which see*).

MUTOSCOPE

Casler's "Mutoscope," here shown, consists of a receptacle having an opening in its face, under which a set of pictures, made on bromide paper, is made to pass. The pictures radiate



Coin-in-the-Slot Form of Mutoscope

from a common centre, on which they turn on an axis. A coin-freed mechanism is fitted to the apparatus, which is operated by turning a handle. There are other forms.

N

NAKAHARA'S PROCESS

A Japanese "black line" process.

NAMIAS' REDUCER

The permanganate reducer, which, under certain conditions, has a similar action to that of the ammonium persulphate reducer.

Sulphuric acid (20% sol.)	40 mins.	8 ccs.
Potass. permanganate (20% sol.)	.80 "	16 "
Water	.10 oz.	1,000 "

It gives even reduction when applied to a wet negative, whereas a dry negative immersed in the solution, is reduced more in the high lights. Greater softness is obtained by treating the dried negative quickly with the reducer, washing, drying and re-immersing. Red or brown stains are caused by insufficient sulphuric acid, and may be removed with a 10 per cent. solution of sodium sulphate containing 2 per cent. of oxalic acid. The use of impure permanganate causes irregular action.

NAPHTHA (Fr., *Naphte*; Ger., *Naphtha*)

Mineral naphtha is known as petroleum ether or benzine (see "Benzine"). Coal-tar naphtha is chiefly benzole (see "Benzene"). Wood naphtha is impure methyl alcohol (see "Alcohol").

NAPHTHALENE RED (See "Magdala Red.")

NAPHTHOL GREEN (Fr., *Vert naphthol*; Ger., *Naphtholgrün*)

The ferrosodium salt of nitrosobetanaphthol-sulphonic acid, used for making colour screens. It is soluble in water, with yellowish-green colour. It is especially useful as it is about the only green aniline dye which satisfactorily absorbs the extreme red of the spectrum. There are various kinds, naphthol green 2.6 being the most satisfactory.

NAPHTHOL YELLOW S (Fr., *Jaune de naphthol S*; Ger., *Naphtholgelb S*)

Synonyms, citronine A, sulphur yellow S, acid yellow S. Several aniline dyes are sold under the generic name of naphthol yellow. Naphthol yellow S is the potassium salt of dinitroalphanaphtholsulphonic acid, and is used for making colour screens.

NAPLES YELLOW

A mixed pigment used in colouring photographs. Commercial Naples yellow is made by mixing zinc white with cadmium yellow, by mixing white lead, cadmium yellow and yellow ochre, and in other ways. The true Naples yellow is a basic lead antimoniate, which has the disadvantage, when used as a water-colour, of soon being affected by foul gases.

NARROW-ANGLE LENS

A lens having a focal length at least twice that of the longest side of the plate.

NATROL

A solution, German in origin, used instead of a preliminary washing for P.O.P. prints; supposed to assist the gold in giving rich tones and to prevent spots. The formula is:—

Sodium chloride (salt)	. 2½ oz.	150 g.
Fused sodium acetate or sodium bicarbonate	. 2 "	110 "
Water	. 20 "	1,000 ccs.

Dilute 1 oz. with 15 oz. of water. Immerse the prints for about five minutes, wash, and tone as usual.

NATURAL COLOURS, PHOTOGRAPHY IN

This subject is of such vast extent and is divided into so many branches, which are treated of individually, that a mere sketchy outline of the whole subject can be given here. The subject may be divided into four main heads: (a) direct heliochromy, (b) interference heliochromy, (c) the bleach-out process, and (d) three-colour work.

Direct heliochromy and interference heliochromy.—Senebier, in 1785, had pointed out that when a spectrum was thrown on to silver chloride, violet and blue were reproduced, but he carried the experiments no further. However, in 1810, Seebeck, the great German physicist, sent to the poet Goethe a treatise of the action of coloured illumination ("Wirkung farbiger Beleuchtung") which is printed in Goethe's *Geschichte der Farbenlehre*, Vol. II., p. 716. Seebeck details the effect of allowing "the spectrum from a perfect prism to fall for 15 to 20 minutes on white damp silver chloride spread on paper and kept by a special device in the same place. I found the silver chloride to be altered in the following manner: in the violet it became reddish-brown (sometimes more violet, sometimes more blue), and even beyond the previously marked limits of the violet this coloration extended, but it was no stronger than in the violet; in the blue of the spectrum the silver chloride had become pure blue, and this colour extended, increasing and becoming brighter right into the green; in the yellow I found the silver chloride frequently unchanged, but occasionally it happened to be more yellow than at other times; in the red, on the other hand, and frequently beyond the red, it had assumed rose-red." Seebeck then describes the effect of two spectral lights—red and violet—and also tests with coloured glasses. The importance of this work must not be overlooked, for it was thirty years before the discovery of the daguerreotype, and the results were photographs on paper. But little notice seems to have been taken of

this work, though this was probably due to its being published in Goethe's book, which is very poor in facts but rich in arguments. Seebeck's work also confirmed Ritter's statement (1801) that there were invisible radiations at both ends of the spectrum.

John Herschel, the son of the renowned astronomer, was the next to discover anew the curious property of silver chloride of reproducing colours ("Philosoph. Transactions," 1840, p. 28, *Athenæum*, 261), and followed Fox Talbot's suggestion of using alternate baths of silver nitrate and sal ammoniac, but Herschel preferred to sensitise his paper just before use, and pressed it in the camera obscura against a glass plate, which prevented any wrinkling of the paper.

He did not succeed in fixing these colours; yet they were half fixed by merely washing with water, and could then be examined by diffused daylight or lamplight without deteriorating. Herschel also discovered that silver bromide gave the same colours as, though less distinct than, the chloride, whilst silver iodide gave the complementary colours. Robert Hunt, in his *Researches on Light*, details numerous experiments both on silver and other substances, and records the occurrence of colours; but the next investigator to warrant attention was Edmond Becquerel, and to his papers (*Annales de Chimie et de Physique*, third series, Vols. XXII., XXV., XLII., 1849—1855) we are indebted for the real foundation of successful heliography; his researches are collected into two volumes: *La Lumière et ses Effets*. He exposed to the spectrum silver plates coated with silver chloride which gave a fairly satisfactory rendering, but the uneven film of chloride caused unevenness of colouring; ultimately, he found it better to obtain an electrolytic deposit of chloride. He also used a solution of cupric chloride (copper sulphate 1 part, salt 3 parts, water 10 parts), and in this the silver plates assumed a violet-white coloration, and gave, on subsequent exposure, not only the spectral colours, but white also. He says: "I think that the substance formed on the surface of the metallic silver is a special chlorine compound, perhaps violet silver subchloride or a mixture of white silver chloride and subchloride."

Nieppe de Saint Victor carried on similar experiments to those of Becquerel; Eder states that one of his heliographs in his possession still shows brilliant colours, forty years after its preparation. Nieppe started with the theory that those chlorides that gave a definite colour to a Bunsen flame were the best for reproducing the colour when used for chlorising the silver plate. He not only obtained the spectrum, but also copied objects in the camera and obtained excellent reproductions of the shimmer of glass and polished metal objects, and also reproduced black, which in many cases reflects the ultra-violet or infra-red or both. He used a varnish of dextrine and fused lead chloride, which was a great protection, and this was further increased by subsequently coating the plate with tincture of Siam benzoïn, and heating till some of the benzoic acid was driven off; his results are recorded in the *Comptes Rendus*, 1851—1859, etc.

In 1851, an American clergyman named Hill claimed to have discovered photography in colours, but eventually the process was proved to be useless. In 1855 and 1856, Testud de Beauregard brought forward the view that a silver photograph without colour possessed a latent power for colour; but no one has ever been able to produce colours by his process—save the discoverer.

Poitevin (*Comptes Rendus*, 1865, p. 1,111) describes his process for obtaining colours on paper, and the following is his final method: "I form upon non-albumenised paper a film of ordinary silver chloride by floating one side of the paper on a 10 per cent. solution of salt; when dry, I float this on an 8 per cent. solution of silver nitrate, or the back of the paper is painted with a mixture of equal volumes of a saturated solution of potassium chromate, and a 10 per cent. solution of cupric sulphate, dried in the dark, and then floated on the silver bath. Chromate of silver is now formed; I wash with plenty of water in order to remove excess of the nitrate salt and add to the last washing water a few drops of ordinary hydrochloric acid till the red chromate salt is converted into white silver chloride. Both these methods of preparing the silver chloride film are equally good. Now, in order to obtain the violet subchloride, I pour into the dish, which contains the paper soaked in water, a small quantity of 5 per cent. stannous chloride solution; about 20 ccs. (about $\frac{1}{4}$ oz.) are required for a whole sheet. Now I expose the sheet, without taking it out of the bath, to the action of light, and preferably in the shade than in the sun; its surface quickly discolours and after five or six minutes, has assumed the desired dark violet colour. It is not advisable to allow the light to act still longer, otherwise a greyish black tone would be obtained, which is not suitable for heliography. After the action of light, I wash the sheet in several changes of water, and then allow it to dry in the dark. In this condition it is very little sensitive to light, and can be kept for a long time." Poitevin used water acidulated with sulphuric acid, or a very dilute solution of mercuric chloride diluted with sulphuric acid for fixing, and subsequently glazed the pictures with albumen.

Wharton Simpson followed with a suggestion to the use of an emulsion of silver chloride in collodion (1867). Saint Florent (*Bull. Soc. Franç.*, 1874) also suggested a method of using collodio-chloride paper, which was exposed to sunlight for 80 to 100 seconds, or till reddish-black; immersed in a bath of alcohol 100 ccs. ($3\frac{1}{2}$ oz.), glycerine 7 ccs. (126 mins.), 1 per cent. tincture of iodine 7 ccs. (126 mins.), and ammonia 6 drops, for 10 minutes; dried in a dark place; exposed under a coloured transparency for about one hour in sunshine; fixed in a 10 per cent. solution of "hypo"; washed and dried in sunshine. In the fixing bath the colours disappear, but reappear when exposed to the sun, or ironed with a hot iron.

Veress, in 1890, followed up on Poitevin's lines, and in the following year Kopp, of Münster, certainly made some advances, which promised well. The best report of his work is found in Valenta's work, *Die Photographie in Natürlichen Farben*, 1894.

He floated raw paper on salt solution, then on silver nitrate and again on salt solution, thus obviating any excess of silver nitrate, which both Becquerel and Poitevin had pointed out as prejudicial to the purity of the colours; the paper was then well washed and exposed, under an acidulated .1 per cent. solution of zinc chloride, to diffused daylight till it had assumed a blue-grey colour. The paper is washed and dried, and made sensitive to all colours, as well as white and black, by treating with a solution made as follows:—

Potassium bichromate	.1,940 grs.	150 g.
Cupric sulphate	.1,940 „	150 „
Distilled water to	20 oz.	1,000 ccs.

Dissolve by the aid of heat, and when boiling, add

Mercuric nitrate	.1,940 grs.	150 g.
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dissolved in as small a quantity of water as possible, and acidulated with nitric acid. A red precipitate forms, which should be filtered out when the solution cools down; then make the filtrate measure 20 oz. or 1,000 ccs. by adding water. This solution will keep well in well-closed bottles. The blue-green paper should be immersed in this for half a minute till completely decolorised, drained and immersed in a 3 per cent. solution of zinc chloride till it again becomes blue, then well washed in running water, superficially dried between blotting-paper, and exposed whilst still damp. The yellow and green of the spectrum appear at once—that is, with about 30 minutes' exposure—and the picture should then be coated as to these colours with a shellac or celluloid varnish, well heated, immersed in a 2 per cent. solution of sulphuric acid till all the colours appear, thoroughly washed and dried between blotting-paper; fixed in the above-given mercury bath, in which the colours disappear, and finally immersed in a sulphuric acid bath and coated with a solution of gum arabic containing 5 per cent. of sulphuric acid. Valenta's improvement was the use of .5—1 per cent. solution of sodium nitrite instead of the zinc chloride solution, and excellent results are attainable.

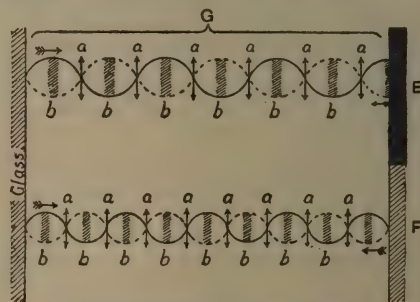
The above process is also applicable to many of the commercial printing-out papers, both gelatine and collodion, if they are immersed in a solution of acidulated zinc chloride, are then well washed and treated with a 10 per cent. solution of hydroquinone.

Krone (*Darstellung der Natürlichen Farben*) has confirmed Valenta's statements, and also Poitevin's and Becquerel's.

So far, merely the practical side of the question has been considered. Schüle assumed that the dark silver subchloride was oxidised on exposure to yellow silver chloride, and this chemical view was supported by many chemists, though physicists considered that the colours were due to thin films, as in Newton's rings, and this was confirmed by the very thin films obtained by Becquerel in the electrolytic chlorising of his plates. The true explanation was first propounded by Wilhelm Zenker in his *Lehrbuch der Photochromie* (1868), and this has been purposely disregarded till this particular stage, because it forms a fitting connection to the next process to be here considered.

Zenker examines the various methods which, up to 1868, had been suggested, and in most cases gives his criticisms of the processes founded on actual experiments; his book (reprinted, 1900), therefore, is extremely valuable. Zenker states: "When different coloured rays penetrate a light-sensitive substance with equal intensity, they must act on the same in absolutely equal manner; every ray, no matter what its vibration may be, must act on all the particles of the substance which lie in its path, set them in motion, and thus chemically alter them. Thus, there may be a general darkening, coloration or bleaching; these must be under one colour the same as under the other; a difference of colour is not conceivable. The facts are, however, quite different when the incident rays meet again outgoing rays of the same phase, that is to say, if we consider that with all these photographic processes the incident rays are again reflected. This takes place most strongly with the daguerreotype, but also with sensitive surfaces lying on other supports, and one can convince oneself of the quantity of reflected light by merely looking at it. Now, if two waves of the same phase meet they give rise to the phenomenon which is called, in the case of water, 'stationary or standing waves.'"

The formation of these waves is shown in diagram A, in which the incident rays are shown in continuous lines, and the returning rays in



A. Stationary or Standing Waves

dotted lines. In E it is assumed that the ray is reflected from a substance with higher refractive index, and in F with a lower refractive index, than G, the sensitive surface. At the points *b b* the reflected ray augments the incident, whilst at *a a* the pull on the ether particles is in contrary directions; consequently there is no movement, and therefore no light. As a matter of fact, in standing waves, the ether particles rise and fall, but there is no propagation of light. Now, it is obvious that if G is a film of sensitive substance, the action of light will be to cause a deposit of silver at the internodal planes *b b*, as shown by the hatched lines, and this deposit is exactly half a wave-length of the incident light apart; therefore, it can only reflect light of that colour which has a wave length of double the distance *b b*.

The truth of this theory was disputed by Schultz-Sellack (*Annalen d. Phys. u. Chem.*, 1871, p. 449), following which further doubt was created by Carey Lea's production of the photo-salts, as he was able to prepare the coloured

substances, produced by the action of coloured light on silver chloride already exposed, by purely chemical means in the dark. Otto Wiener (Wiedeman's *Annalen d. Phys. u. Chem.*, 1890, p. 203) was able to prove experimentally the formation of Zenker's standing waves, and the following is a brief summary of his work: With homogeneous illumination, there is formed in front of a reflecting surface a series of standing waves parallel to the reflecting plane. This is shown at B, in which R R is the reflecting surface, and the planes of equal phase are shown in section, the nodal points in dotted lines, and the waves in maximum action in continuous lines. Now, if a light-sensitive film be coated on the glass, the metallic silver resulting from the

light action must be $\frac{\lambda}{2}$ apart, but as this distance,

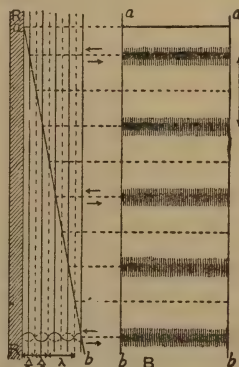
one half wave-length for red light, would be about $\cdot 3 \mu$, it is obvious that it would be invisible to the naked eye. Wiener, therefore, coated his sensitive film, $a b$, at an acute angle with the reflecting surface, and it will be at once seen that the distance of the silver laminae is increased,

for if $\frac{\lambda}{2}$ is the distance between two maximum wave planes, the separation, b , of the silver laminae would be: $b = \frac{\lambda}{2} \sin a$. Wiener used

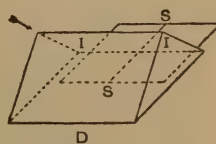
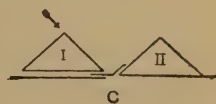
collodio-chloride of silver emulsion thinned down with about 15 to 20 parts of solvent, and thus obtained a colourless, transparent emulsion in which the silver laminae were distinctly visible. Later, he was able to confirm this with silvered glass plates fumed with iodine.

In 1895, Wiener (*Annalen d. Phys. u. Chem.*, 1895, p. 225) examined the question of the Seebeck and Poitevin processes on paper, to determine whether the colours were apparent or body colours—that is to say, whether they were produced by interference or absorption. To determine this question, he used a right-angle prism of highly refractive glass, $\mu = 1.75$ for D, with its hypotenuse on the colour pictures, the intervening air space being filled with benzole so as to prevent total reflection, and thus securing for light rays entering normal to the side surfaces an angle of incidence of 45° , so that the ray entering the silver chloride must form a considerable angle with the normal to the surface. The difference in path of the interfering light waves will, in comparison with vertical incidence, be greatly changed, and according as the colours are thus altered or not they are interference or body colours. The prism was so placed upon one half of the photographed spectrum that the line between the hypotenuse and the side face I (diagram C) cut similar colour lines at right angles. The eye of the observer was placed in the prolongation of the same surface I (the arrow indicates the line of vision) so that a line, S, drawn before the experiment, in the direction of a single colour—as, for example, the yellow—appeared straight when viewed through the air and prism. D shows another arrangement, in which the spectrum reproduction was cut in half perpendicularly to the reference mark after drawing the latter in the yellow. One of the parts was placed upon the side of an auxiliary prism, I I, fastened to a level glass plate, upon which

the other half of the sheet was so placed that the marks came together. Finally, prism I, with the high refractive index, was set upon the second half, benzene poured between, and the eye placed in line with the reference mark and with the surface of the principal prism. Wiener thus sums up his conclusions drawn from the above experiments: In the Seebeck and Poitevin processes there is no change of colour under the above conditions, and they are, therefore, body colours; this is also confirmed by the fact that these pictures show the same colours by transmitted as by reflected light. The colours of the Becquerel pictures, produced on an underlying silver mirror, were chiefly produced by interference. Carey Lea and Krone proved that the substances present in the Seebeck and Poitevin processes were capable of yielding compounds which embrace almost all the spectral colours, if not all their tones, and the reason why they



B. Standing Waves parallel to Reflecting Plane



C and D. Use of Prism to detect Interference or Body Colours

agreed in hue with the illumination-producing decomposition is that of all the coloured substances capable of being produced, only those will be stable which agree in colour most nearly with the incident light, since these will best reflect and least absorb it, and can, therefore, be least changed. Decomposition products of other colours, on the other hand, absorb this light, and will be again decomposed. Proof of this was found when a spectrum was thrown at right angles on a colour photograph of the spectrum. It was then found that a correctly-reproducible illuminating colour was capable of decomposing all colours differing from it, but similar colours remained unchanged. It is, therefore, fundamentally possible that coloured illumination shall, in suitable substances, produce similar body colours, and such substances Wiener termed "colour receptive."

In 1891, Prof. Gabriel Lippmann, lecturing at the Académie des Sciences (*Comptes Rendus*, 1891, p. 274), explained at length the theory of interference, and exhibited actual photographs in colours produced by his method, which is essentially that of Wiener, and theoretically described by Zenker. He used a transparent gelatine emulsion of silver bromide with the sensitive

film in contact with a film of mercury and the glass of the plate presented to the lens. From what has already been said, it will at once be seen that here was the ideal method of recording, if possible, the formation of standing waves, and if formed they would naturally reflect the colours of the incident light.

Lippmann's own description (*Phot. Journ.*, 1897) is by far the easiest to grasp, and he says: "Now, how is it that we see the colour? The photographic operations are the same as in ordinary photography, the result of the operations is the same, a similar deposit of reduced silver is obtained, and the materials of which the image is composed are the same as those in a colourless plate. The difference is that the plate has acquired such a structure that it decomposes the light by which it is illumined, and sends back to the eye of the observer elements of white light, which together make the natural colours of the object. In the same manner the colourless drops form the rainbow. A soap bubble appears coloured, although consisting of a colourless solution, and mother of pearl appears coloured although made of colourless carbonate of lime. It is a phenomenon of interference due to the structure which the deposit has acquired; if you were to use a plate without a mirror you would get an ordinary negative, but the presence of the mirror changes everything, and this is how it is done: You know that light is made up of vibrations, just as sound is; these vibrations give rise to light waves that rush through the ether and the plate with a velocity of 300,000 kilometres per second; therefore, they impress the plate more or less strongly, and thus leave a design of different intensities of the image, but as they rush through the plate they leave no record of their form. And this is what I mean by their own form: Each ray of light of a certain colour has a certain structure; it is made up of waves which have a certain wave-length; you know a wave-length is the distance between the crests of two succeeding waves; red has a comparatively great wave-length, blue has a much smaller one, and the intermediate colours have each a distinct and intermediate length of wave. If you put no mirror, each train of waves rushes through the plate and wipes off every record of its own form by reason of its velocity; you cannot expect a thing which moves with a velocity of 300,000 kilometres in a second to give a photograph of itself. If you put a mercury mirror behind the plate, then the following phenomena occur: The light is reflected back on itself; the light rushes in with a velocity of light and rushes out again with the same velocity; the entering and issuing rays interfere, and the effect of the interference is that vibration takes place, but the effects of propagation are stopped, and instead of having propagated waves we get stationary waves—that is, the waves now rise and fall, each in its own place; they pose, therefore, in the interior of the film and impress their form upon it, the largest movement giving the strongest impression, and where the movement is naught the impression is naught. So that you have the form of the vibration impressed in the interior of the film by the photographic

process, and the photographic film has really now acquired the structure of the incident rays, because they have become stationary, and impressed their form upon it. The result is, that if you look through the film you see nothing special; it looks like an ordinary negative; but if you look at it by reflection, then you see it coloured. And this for the following reason: Suppose at one place the plate has been impressed by red light, the red light has impressed its structure on that part of the plate, and that part of the plate is now able to reflect back to our eyes only the red part of the white rays—only the red element which is a component part of white light, and similarly with every part of the spectrum; it is a mere mechanical adaptation of the form of the deposit to the form of the light vibrations."

Now, if the capability of one of the Lippmann heliochromes to reflect the colour of the original incident ray back to our eyes is dependent on the distance of the laminae of silver one from the other, it is obvious that if we could increase this distance the colours should change. This is precisely what takes place. It is only necessary to expose a heliochrome to steam or aqueous vapour, which is absorbed by the gelatine; this swells, and the distance between the laminae is increased. Now, assuming that this distance of separation for the extreme violet be half one wave-length, 4,000 ten-millionths of a millimetre, that is, 8,000, and we steam it so as to increase the distance by one-fourth, then our 8,000 becomes 10,000, and one-half of this would be 5,000, which is the wave-length of the bright blue; therefore, this would be the colour reflected to the eye. This change of colour with steaming or absorption of aqueous vapour can be proved with any heliochrome. It is obvious that there might well be heliochromic effects produced on daguerreotypes, with which a polished silver plate with a sensitive film is used, and such coloured results have actually been observed (J. Nicéphore Niepce).

Bleach-out Process.—A. Vogel (*Schweigger's Journal*, 1813, pp. 229–236) recorded the fact that under coloured glasses the colours of tinctures of certain flower petals were bleached, but that under glasses of the same colour as the tinctures there was no change. This subject was studied by Herschel (*Philos. Trans.*, 1842) and Robert Hunt (*Researches on Light*, 1844, p. 170), and the former propounded the law that dyes were bleached when exposed under their complementary colours, but were not bleached when exposed to light of the same colour. In 1889, R. E. Liesegang (*Phot. Archiv.*, No. 633, p. 328) recommended the admixture of three fundamental colours—red, yellow and blue—and in 1891 (*Phot. Almanach*, 1891) he stated that the bleaching took place more rapidly in oxygen. Two years later (*Phot. Archiv.*, 1893, Nos. 729, 730) he also published a series of experiments on the increase of rapidity of bleaching aniline dyes by the addition of certain sensitisers, such as stannous chloride, oxalic acid, hydroxylamine, ammonium sulphocyanide, etc.

Wiener, in his already cited paper (*Annalen d. Phys. u. Chem.*, 1895, p. 225), includes a special

chapter on "the theoretical basis of a method of colour photography with body colours," and says: "In order that a substance sensitive to light can be chemically changed by the action of any kind of light, it must absorb it." The converse proposition is not general. The absorbed light can, for example, be exclusively formed into heat. A distinction is, therefore, made between thermal and chemical absorption of light. For the sake of simplicity of expression I shall designate as a regularly absorbing light-sensitive substance one which is sensitive to all colours which it absorbs, and is affected by each colour in proportion to the capacity for absorption. That there are such substances, at least to a considerable degree of approximation, is known. Upon their existence is based the important law of optical sensitisers established by H. W. Vogel. It is conceivable that the regularly absorbing light-sensitive substance may be decomposed by the action of light to form coloured substances also regularly absorbing and light-sensitive. I will designate as a colour-receptive substance a black regularly absorbing light-sensitive substance whose products of decomposition consist only of monochromatic regularly absorbing light-sensitive substances of at least three radically different colours, and, besides these, of a white substance which, however, is the least readily formed. These colours must be radically different in order that by their mixture with one another and with white all compound colours may be possible. In distinction from these compound colours the unmixed colours will be called ground colours. The monochromatic substances reflect only one colour well. They must absorb the others the more completely they differ from them. With these preliminaries it may be shown that a colour-receptive substance reproduces the colour of the illumination correctly. First, let the colour of the illumination agree with a ground colour. It will be absorbed by the black body and produces a decomposition substance which, by hypothesis, is regularly absorbing and light-sensitive. In this decomposition different coloured substances are formed. Those not agreeing in colour with the incident light absorb it, since, by the hypothesis, they are monochromatic, and must absorb all illumination different from their colour. Since these are regularly absorbing light-sensitive substances, they are also decomposed by the light which they absorb. On the other hand, the substance of the same colour as the incident light is not decomposed, since it does not absorb. In the end, therefore, it alone can remain in company with the white substance. The amount of the latter is, by hypothesis, very slight, and its effect upon the colour is, therefore, noticeable only under strong illumination. Where the colour of the illumination differs from that of a ground colour, but is intermediate between two ground colours—as would, for example, be the case with green, and if yellow and blue were ground colours—the coloured substances would suffer least decomposition which reflect green best—that is, the yellow and blue. A green mixture would thus arise besides the small quantity of white. In white light all the colour substances would be decomposed, leaving

white alone. In the absence of illumination the substance would remain black."

Incited by Wiener's theorising, Vallo (Mon. d. la Phot., 1895, p. 318) used aniline purple (red), Victoria blue and turmeric on paper and exposed for three or four days to sunlight and obtained coloured results. The subject was followed up by Worel, who published (*Auz. K.K. Akad. Wissent. Wien*, 1902) details of his process, though he had shown results at the end of 1901, and he used anethol as a sensitiser. Neuhaus followed up the subject (*Phot. Rund.*, Jan., 1902, and Eder's *Jahrbuch*, 1902-3-4), using oxidising substances, such as hydrogen peroxide and the persulphates, as sensitisers. Szczepanik (*Phot. Korr.*, 1902), instead of mixing the dyes, coated them in three superimposed layers, and in 1906 a commercial paper, "Uto," was placed on the market by Smith and Co., of Zurich. From a practical point of view all these preparations leave much to be desired, but such a paper with reasonable sensitiveness would be of great practical interest.

Three-colour Processes.—These are dealt with separately (see "Three-colour Photography" and "Screen-plate Colour Photography"). The only other process with which it is necessary to deal is the—

Prismatic Dispersion Process, which practically splits up the light reflected from any object into its spectrum, and allows this to act on the sensitive surface, and then reconstitutes the image. In this process no dyes or filters are used, and it may be considered to be nothing more than a method of optical synthesis, in which the whole spectrum and not three colours are used. The first suggestion for the process was made in an English patent, No. 16,548 of 1895, taken out by F. W. Lancaster. The essentials of the process are as follow: A grating of black lines with clear interspaces is arranged between the object and the camera, a prism is arranged behind the lens with its axis parallel to the bars of the grating, the dispersion of the grating being such that when the lens is focused on the grating the images of the clear interspaces form a series of spectra on the plate, which are broken up by the light reflected from the object so that the image consists of lines of shaded intensities. From this negative a transparency is taken on an ordinary lantern plate and placed in the position occupied by the original dry plate, and the coloured picture is then reconstituted by placing a light behind the grating and viewing the picture at the distance of normal vision. In the *British Journal of Photography* for Jan., 1904, Dr. Rheinberg suggested a similar process, and it has since been taken up by Cheron, Bruignac and Raymond, and the latter seems to have obtained the most practical arrangement. The following description is taken from "Colour Photography," the supplement to the *British Journal of Photography* for Mar. 1, 1907: To an ordinary camera is fitted a diaphragm behind the lens, and this diaphragm should preferably be a narrow rectangle. In front of the plate is fitted an ordinary cross-line screen, with preferably opaque lines wider than the interspaces; behind the screen is placed a prism of

from 3 to 8 degrees, and then the plate. The exposure is made in the usual way, and a positive from a negative made and placed in the position of the negative. At present the process is but in its infancy, but it promises well, the only disadvantages being the prolonged exposures required, and the difficulty of exhibiting the pictures to more than one person at a time.

NATURAL HISTORY PHOTOGRAPHY

The equipment of the naturalist photographer largely depends upon the subjects to which he intends to devote attention. (For example, the reader will find further useful and suggestive hints under such headings as "Insects," "Fish," "Birds," etc.) For much natural history photography a good reflex camera is essential. For photographing very shy birds and beasts, the improved type of telephoto lens, having an aperture of $f/7$ or $f/10$, and requiring only a comparatively short extension of camera to obtain on a small plate a large image of an object at a considerable distance, will be found of the greatest service. All cameras and tripods used should be strongly made and not have any bright metal fittings or highly polished surfaces to reflect the light and attract attention. The tripod may with advantage be painted a dull, dark green, and the camera and fittings dead black. A good, deep, easily-fitted hood for the front of the lens is desirable to cut off strong reflections on the front surfaces of the lens, which are often responsible for general flatness or hazy definition. The whole of the apparatus should pack into thoroughly water-proof cases, for the naturalist photographer may frequently have to face inclement weather. A well-made Alpine rucksack is a convenient receptacle for parts of the outfit when long distances have to be covered on foot. In selecting apparatus, weight must be considered, but for the sake of lightness and portability, strength and rigidity must not be sacrificed. The use of aluminium for any parts of photographic apparatus to be used in the field for natural history is a questionable advantage. If one is working within reach of the salt spray of the waves, or where sea water is likely to come in contact with the outfit, there will soon be trouble with any aluminium fittings. The tripod should be of well matured wood, and of the three-fold type, closing to a small space, and capable of considerable adjustment for varying heights and inequalities of the ground. As it is important to obtain as faithful a monochrome rendering of the colours of the original subject as possible, isochromatic plates should always be used if there is sufficient light to obtain a good exposure. Prints should be made upon platinotype for preference, or bromide paper, so as to obtain all possible detail and gradation.

"NATURALISTIC PHOTOGRAPHY"

Under this title a book was published by Dr. P. H. Emerson, in 1888. Its effect was to lead to the production of a class of photographic work which had hitherto received little attention. The hollow artificiality of much of the photographic work that had been accepted with approval was realised, and a school of workers

sprang up who gave their attention to the beauties of Nature. Many strikingly fine landscape subjects were produced which demonstrated that photography was fully capable of taking its stand firmly as a graphic art of no mean capacity. Pictorial photography in the true sense sprang into being. Less and less reliance was placed on the theatrical accessories of the studio, and photographers went direct to Nature for their subjects and effects.

NATURE PRINTING

Printing on paper prepared with flower juices (see "Anthotype") and upon fruit; for the latter purpose, flexible stencil plates are attached to the green fruit, chiefly apples and peaches, the sun then printing the pattern as the fruit ripens over a period of several weeks. Film negatives may be used, but they must possess extreme contrasts.

NEBULÆ, PHOTOGRAPHY OF (See "Stars, Photographing.")

NEEDLEHOLE (See "Pinhole.")

NEGATIVE (Fr., *Négatif*; Ger., *Negativ*)

An image in which the lights and shades are reversed; a term first used by Sir John Herschel, in 1840, to describe Talbot's pictures upon calotype paper. The first negatives were upon paper made translucent by waxing, but glass and celluloid have now almost wholly replaced paper.

NEGATIVE ABERRATION

The opposite of ordinary (positive) aberration in a lens. A concave lens showing negative spherical aberration can be used to correct positive aberration in a convex lens.

NEGATIVE BOX (See "Box, Negative.")

NEGATIVE CARRIERS AND HOLDERS (See "Enlarging Camera," "Plate Holder," etc.)

NEGATIVE COLLODION PROCESS (See "Collodion Process (Wet).")

NEGATIVE ENVELOPE (Fr., *Enveloppe aux clichés*; Ger., *Negativ-houvert*)

Thin paper envelopes used for storing negatives. Particulars of the subject, date of exposure, and other details may be written outside. (See also "Negative Storing.")

NEGATIVE LENS

A concave (diminishing) lens, which cannot focus rays upon a screen to produce an image.

NEGATIVE NUMBERER (Fr., *Numérateur aux clichés*; Ger., *Negativenzähler*)

There have been several devices for numbering negatives. In one, a small stencil which changes automatically to a higher number at each exposure is fitted to the camera or dark-slide, so that it comes against a corner of the plate, the number therefore appearing on development. The sheaths of some hand cameras have notches indicating their respective numbers, which show at the edge when

developed; this, of course, only indicates the order in which each dozen plates are exposed. Some studio operators have a set of separate printed numbers, to slip in a small grooved frame, after the principle of a church hymn-board. This is laid near the sitter so as to come at the margin of the plate, and is changed at each exposure.

NEGATIVE, PAPER (See "Paper Negatives.")

NEGATIVE, PERFECT

The term "perfect negative" is frequently met with in photographic literature; but a negative that is perfect for one printing process may be quite unsuitable for another one. A nice-looking, clean negative, say, one developed with hydroquinone, will often give a print far inferior to one sometimes obtained from a yellow-stained pyro-developed negative. Of the good average negative, R. Child Bayley says that, placed film side down, upon a sheet of white paper, and looked at from above, the edges on which the light did not fall in the camera ought to be almost clear; a slight trace of greyiness is unavoidable, unless a backed plate is used. There must be an appreciable quantity of greyiness in the very deepest of the shadows, or the plate has not had sufficient exposure; if there is too much the plate has been over-exposed. The highest lights, the most opaque portions, are tested by placing the film in contact with printed matter; the print must be considerably darkened as compared with the lighter parts of the negative, but it should be possible to read it through even the most opaque portions without difficulty; otherwise, whether the plate was over-exposed, correctly exposed, or under-exposed, it has been over-developed.

At one time the wet-collodion negative was thought to give the effect to be aimed at in the dry plate; but at the present time the Hurter and Driffield dictum, that the negative should be judged by its printing qualities alone, is generally accepted.

In process work, various classes of negatives are used. They may be in "half-tone," "grain," or in "continuous tone." The last-named resembles an ordinary negative, with graduated tones, not broken up into dot or grain, but must be of very good quality, with full range from almost clean glass in the shadows to perfect opacity in the lights. Such a negative for photogravure or collotype should not be hard, but somewhat thin and full of detail, with a uniform gradation throughout.

NEGATIVE, REVERSED

A negative from which is produced a print that represents the object reversed as regards left and right. It is easily produced by placing the plate in the camera glass side towards the lens. Photo-mechanical workers use, as the daguerreotype workers did, a reversing mirror or prism fitted to the front of the lens and throwing a reversed image direct upon the plate. Negatives already made may be reversed by stripping the film and replacing it in a reversed position. Reversed negatives are largely used for carbon and collotype work. (See also "Inversion, Lateral.")

NEGATIVE STORING (Fr., *Magasinage des clichés*; Ger., *Negativenlagern*)

Negatives are best stored in wooden or metal boxes. (See "Box, Negative.") Grooved boxes and drawers are favoured by some, others preferring boxes without grooves and placing each negative instead in an envelope bearing the number, title, and other particulars. This takes up much less room, but the negatives cannot be inspected without removal from the envelopes, unless these are transparent. Films are preferably stored in albums with stout leaves, in which slits are cut to hold the four corners; envelope albums are also made.

NEGATIVES, OWNERSHIP OF

Questions as to the ownership of the copyright in negatives and the ownership of the negatives themselves constantly arise in professional work. Taking the ordinary case in which a photographer makes, to the order of a customer, a negative and supplies prints from it, the copyright is the customer's, but the negative itself is the property of the photographer, and the latter is free to retain it, destroy it, or apparently do anything with it short of printing from it, enlarging from it, or copying it unless ordered to do so by the customer. (The term "customer" is here synonymous with "sitter," except in cases where the person who remunerates the photographer is not the person who is photographed.) This applies also to all the superfluous and rejected negatives made by the photographer in the course of producing a satisfactory photograph. When such negatives are sold, the buyer acquires the rights held by their maker; that is, he can do with the negatives as he pleases short of infringing copyright; in this connection, though, it is of interest to read the article under the heading "Copyright." Naturally, the buyer does not buy the right to reproduce the negatives, because that right was not possessed by the maker of the photographs; and no greater title in any property can be conveyed to a second party than was possessed by the first party. The English law has always upheld the photographer in retaining the negatives of photographs supplied; in one case, for example, the High Court decided that duplicate negatives made by a photographer for the purpose of executing an order for prints, the duplicate negatives being charged to the customer, must remain the property of the photographer.

NEOMONOSCOPE (Fr., *Néomonoscope*; Ger., *Neomonoskop*)

Bean's viewing apparatus for photographs, invented about 1862, and consisting of a conical box, with a lens or lenses at the upper end and a portion of one side removed to admit light. The bottom could be withdrawn for the inspection of transparent objects.

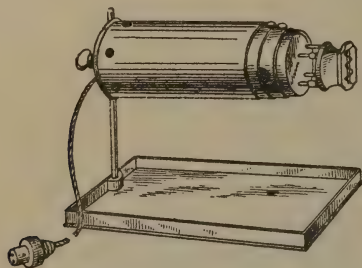
NEPHOGRAPH (Fr., *Néphographe*; Ger., *Nephograph*)

An apparatus used by meteorologists for photographically registering the height and position of clouds. It is furnished with a camera, having an electrically-operated shutter, which may be

worked from a distance. Two or more of the instruments are placed at different stations, sometimes far apart, the separation and exact relative position of which have been accurately ascertained, and exposures are made simultaneously from each. The resulting negatives or prints enable the required data to be calculated by photogrammetric methods.

NERNST LAMP (Fr., *Lampe Nernst*; Ger., *Nernst-Licht*)

A lamp in which a stout filament composed of magnesia and the oxides of rare earths is rendered incandescent by the electric current. It was invented by Walther Nernst, in 1897. This illuminant is excellent for enlarging, optical projection, and cinematography with a



Nernst Lamp

small disc. It is very economical of current, carries its own resistance, and is usually furnished with a short length of flexible wire and a connection that merely requires insertion in the bayonet catch of an ordinary incandescent glow lamp from which the bulb has been removed (see illustration). The filaments when broken are readily replaced with fresh ones. Various useful modifications by R. W. Paul and others have rendered the lamp still more adaptable for photographic and projection purposes.

NESSLER'S SOLUTION

Used for testing certain chemicals—the ammonium salts, for example, with which it gives a coloration or brownish precipitate. It is made by dissolving 30 grs. of potassium iodide in $1\frac{1}{2}$ drms. of distilled water, and boiling with successive portions of solid mercuric iodide until some of the latter remains undissolved. The liquid is then added to $1\frac{1}{2}$ oz. of distilled water, filtered, and the filtrate mixed with 120 grs. of caustic potash dissolved in 4 drms. of water, and the whole again filtered. There are other formulæ.

NEUHAUSS'S BLEACH-OUT PROCESS

Dr. Neuhauss, of Berlin, has paid particular attention to the bleaching-out process, and gives the following instructions for working the same:—

Soft emulsion gelatine	2 oz.	110 g.
Distilled water to	20 „	1,000 ccs.

Allow to soak in the water, melt by the aid of a water-bath, and add with constant stirring—

Methylene blue BB (Bayer) (·2% sol.)	528 mins.	60 ccs.
Auramine, concentrated (Bayer) (·2% alcohol sol.)	132 „	15 „
Erythrosine (Schuchardt) (·5% sol.)	264 „	30 „

Then filter and heat for four or five hours to 104° F. (40° C.) before coating. When dry, the plates must be bathed in—

Hydrogen peroxide (30% sol.)	660 mins.	75 ccs.
Ether to	20 oz.	1,000 „

for at least five minutes. Instead of the ether solution, the following may be used, and gives greater sensitiveness:—

Chloral	176 grs.	20 g.
Caustic soda (10% sol.)	5 mins.	·5 ccs.

Instead of bathing the plate in the peroxide solution, the latter may be added to the gelatine, and then the following formula should be used:—

Methylene blue BB (as above)	480 mins.	50 ccs.
Auramine (as above)	192 „	20 „
Erythrosine „	384 „	40 „

Add these to the gelatine solution at as low a temperature as possible, and add 10 per cent. of the total quantity of 30 per cent. solution of hydrogen peroxide, and immediately coat the plates.

NEUTRAL OXALATE (See “Potassium Oxalate.”)

NICKEL (Fr. and Ger., *Nickel*)

The electro-deposition of nickel has lately come into considerable use in the graphic arts. Zinc etchings are often nickelled to prevent corrosion. Stereotype plates are nickel faced to make them wear and print better. Nickel and nickel steel electrotypes are being produced by direct deposition on the wax mould.

NICOL PRISM

Used in microscopy for polarising light, and consisting of a small block of Iceland spar one of the edges of which is cut to an angle of 68° to the long axis. The prism is divided to form two prisms, which are cemented together by Canada balsam. A ray of light passing through the cemented surfaces is split up into two portions; one, known as the ordinary ray, passes out at the side and is lost, whereas the other, the extraordinary ray, emerges from the end of the Nicol prism and through the object which is being examined into the microscopic objective. The prism is mounted in a revolving cell under the stage of the microscope. (See also “Polarised Light.”)

NIEPCE, JOSEPH NICÉPHORE

Born at Châlons-sur-Saone, 1765; died 1833. A French chemist who began his photographic experiments about the year 1814. In 1824 he obtained light impressions on bitumen spread upon plates of metal. Six to eight hours' exposure was necessary, when the parts acted

upon by light became hardened and were rendered insoluble, while the rest could be dissolved away. The exposed portions of the metal were then etched and used as printing plates. On December 5, 1829, he entered into an arrangement with Daguerre to exchange with one another information regarding all their attempts to fix the pictures obtained by the camera obscura. Niepce and Daguerre worked together until the former's death, when his son Isidore took his place.

NIEPCEOTYPE

One of the earliest photographic processes, and called by the above name after its discoverer, Niepce. He found that bitumen became insoluble by the action of light (see "Asphaltum"). Pewter plates were coated with bitumen and exposed to light under a print. Afterwards, efforts were made to expose the plates in the camera, but the necessary exposure was found to be excessive, so that the process had only a limited application. Niepce at first only endeavoured to get a picture on the plate in the bitumen varnish, but afterwards he etched the plates to make printing blocks, and thus was the first to make photo-engravings. The earliest photo-engraving by Niepce is a portrait of Cardinal d'Amboise, now preserved in the museum of Châlons. It was copied by contact from a print.

NIEVSKY'S PROCESS

A ferrotype process in which ferrotype dry plates are used instead of wet collodion. Introduced by L. Nievsky in 1891.

NIGHT EFFECTS

These, both artificial and real, will be found described under various headings; for example, "Night Photography," "Moonlight Effects," "Candle-light Effects," "Firelight Effects," etc.

NIGHT PHOTOGRAPHY

Photography by the aid of the artificial light of towns or by that of the moon. The practice of producing "night photographs" by what is known as a double exposure—a very short one by day and then by leaving the camera in position and giving a long exposure at night—does not give true night pictures. The exposure necessary for true night photography is not so protracted as might be supposed, and it is possible nowadays to take "snapshots" in well lighted streets at night, the camera being held in the hand, and a very large aperture and the very fastest plates being required. Ordinary night work can be done easily with an ordinary camera and lens, and the fast plate used for daylight work. With a lens working at $f/8$, a plate of a speed of about 250 H. and D. and the time about one hour after sunset, the exposure required for different classes of subjects will work out somewhat as follows: Illuminated shop windows, decorations, etc., two minutes; the same subjects, not including the lights themselves, but only the effects of lights on the objects, five minutes. Open subjects, such as streets and squares in towns well lighted, ten minutes; the same subjects, when heavy dark objects have to be registered with a certain

amount of detail, 20 minutes. The country-side on a bright moonlight night, 30 minutes; but this subject is very variable in character and conditions, so that this estimate is only approximate. These exposures are given only as bases to start from, and each worker must find out his own exposure data. If snow is on the ground the exposure, as a rule, can be halved. If the ground is wet with rain water (not merely greasy), one-third can be taken off the exposure. Moonlight or its absence makes a great difference in the duration of exposure, and at least one third can be taken off when strong moonlight is present. On the country-side, where there is little artificial light available, the absence of moonlight will make night work, when there is no snow on the ground, almost impossible. The nature of the subject again will greatly influence the time of exposure. If night exposures are to be accurately and quickly determined, one must be able to consult his record of exposures, each of which must be kept with the time, place, state of the weather, plate, aperture of lens, etc., all recorded for future reference. If instead of using the lens at $f/8$ it is possible to expose at $f/3$, as in the case of certain modern but expensive lenses, the exposure will be reduced to at least one-eighth of those before given; and by using a plate working at 400 H. and D., then the exposure can again be halved. To be able in $2\frac{1}{2}$ minutes to take a subject which under the former conditions required 40 minutes makes a wonderful difference to the photographer's comfort on a cold and inclement night; to reduce $1\frac{1}{2}$ minutes to 5 seconds is to be able to get figures showing little movement; while to give one-third of a second instead of a minute is to take "snapshots" in the streets with the camera held in the hand.

It is now a matter of common practice in London and other well-lighted towns to take moving figure subjects by the light of the street lamps. There is much difference of opinion as to whether isochromatic plates give better results than the non-colour-sensitive. The photographer should experiment with the fastest plates obtainable, including Extra Speedy (not the press variety, which are designed to give too much contrast) and the Super Speed Ortho. The developing of negatives of night subjects is as difficult as the exposing. Plenty of water should be used. Perhaps the plan most favoured is to begin development with a developer of ordinary strength (without any bromide), and after detail is fairly out to pour off the developer and, after rinsing the plate, cover it with water and leave it to progress by itself. Many get excellent results by diluting the developer with three to four times the usual amount of water and letting the development proceed very slowly. Anyway, a night negative will look a poor, weak thing to a day worker. Some night workers find that the warming of the developer tends to reduce halation, and to soften the hard results caused by fog. Taking the normal temperature of the developer to be about 65° F. (18° C.), it may with many plates be gradually raised to 80° F. (27° C.) without the film leaving the glass, but great care must be taken in handling the film in its softened con-

dition. As to developers, metol alone, pyro soda, rodinal, etc., are used. When a negative shows bad halation, it should be bleached with the ordinary mercury bath, and then "surface developed" only with some quick-acting developer, whipping out the plate before the developer has time to work through to the halated parts.

NITRE (See "Saltpetre.")

NITRIC ACID (Fr., *Acide nitrique*; Ger., *Salpetersäure*)

Synonyms, aqua fortis, hydrogen nitrate, HNO_3 . A colourless, fuming liquid when pure, which strongly attacks the skin, causing painful burns, or with short contact a brown stain. It is prepared by distillation from saltpetre and sulphuric acid. Used as a preservative in the pyro developer. The acid should always be kept in a glass-stoppered bottle. Should the acid be spilled upon the clothes or skin, apply chalk, lime, or magnesia.

In process work, nitric acid is the universally-used mordant for etching zinc. From 5 to 20 per cent. is the range of baths employed.

NITROCELLULOSE (Fr., *Cellulose nitrée*; Ger., *Nitrocellulose*)

Formed by the action of nitric acid on cellulose, and important as forming the basis of all collodions and celluloid. (See "Pyroxyline.")

NITROGEN IODIDE

A black, extremely explosive powder. NHI_2 . It is of purely theoretical interest as being very light-sensitive.

NITRO-HYDROCHLORIC ACID (Fr., *Eau régale*; Ger., *Königswasser*)

Synonyms, aqua regia, nitro-muriatic, chloro-nitrous or chloroazotic acid. Miscible in all proportions with water and alcohol. A fuming yellowish liquid made by mixing 1 part of pure nitric and 3 parts pure hydrochloric acid. It is used to dissolve gold and platinum, and should be kept cool and in the dark. The fumes cause intense irritation to the mucous membrane.

NODAL POINTS, OR GAUSS POINTS

A ray of light falling obliquely upon a plate of glass or other transparent medium does not pass through in a straight line, but is refracted and emerges in a direction parallel to its original

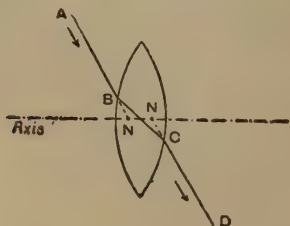


Diagram showing Nodal Points

path. The same thing occurs when a ray falls obliquely upon the surface of a lens, as shown in the diagram. A ray of light proceeding from A enters the lens at B, is refracted and

leaves it at C, proceeding to D in a parallel direction. A B and C D extended to the principal axis of the lens give the two nodal points N N'. That nearest the object is called the "node of admission," and that nearest the image the "node of emergence," or "node of emission." It is from the latter that the focal length of a lens or combination of lenses is measured, and at this point a lens for use in a panoramic camera must be pivoted. The nodal points are not necessarily situated within the lens. They may be before or behind it, and they may be crossed; that is to say, the node of emergence may be farther from the plate than the node of admission. With many modern anastigmats the nodes are so far outside the lens that considerable difference in the camera extension is necessary, according to whether the convex or concave side is turned to the object.

NORRIS'S COLLODION PLATES

One of the earliest forms of collodion dry plates, introduced by Dr. Hill Norris, of Birmingham, in May, 1855.

NORWICH FILM (See "Film.")

NUDE, PHOTOGRAPHY OF THE

The nude figure, male and female, is extensively and successfully treated by painters and draughtsmen. To photographers, however, this particular class of work offers less opportunity for successful effects. In some hands results have been secured that are quite pleasing and satisfactory, but in the ordinary way the chances of complete success are remote. The great difficulty lies in the fact that the photographer does not possess the unlimited facilities of the artist for idealising, for combining, modifying, emphasising, and suppressing, to secure the final satisfactory result. For purposes of figure study, good photographs of the nude have a real value and use. The introduction of nude figures into landscapes has also been successfully accomplished in some cases. But the treatment of the single nude figure for pictorial purposes is seldom satisfactory in the photographer's hands, although this is not because photography is not eminently capable of rendering the beautiful contours, texture, and delicate light and shade of the human body. The difficulty lies rather in first securing the perfectly artistic model, and then rendering it by photographic means with that ideal perfection and purity which should characterise all renderings of the nude figure. Too often the result is mere nakedness, which is a different thing altogether. On the whole, therefore, this class of work is better left alone by the ordinary photographer.

NUMERICAL APERTURE

Usually written N.A. The present system, almost universally adopted, of describing the aperture of microscopic objectives and substage condensers was devised by Abbé, in 1873. The numerical aperture of an objective is the sine of half the angle of aperture multiplied by the refractive index of the medium in which the objective works (air in dry lenses, water, oil, etc., in immersion lenses).

OBERNETTER'S PAPERS

A collodio-chloride paper, introduced in 1863, and a gelatino-chloride paper, in 1884, both by J. B. Obernetter, of Munich.

OBERNETTER'S PROCESSES

A photogravure process (*see* "Lichtkupferdruck") and a printing process (*see* "Ferric Salts, Printing with").

OBJECT GLASS

Abbreviation, O.G. The image-forming lens of a telescope or microscope. (*See* "Objective.")

OBJECTIVE

The lens in any optical system—such as a telescope, microscope, or photographic camera—which forms or projects an image either for examination by means of an eyepiece or for reception by a sensitised surface. The objectives of ordinary telescopes and microscopes are usually corrected for visual use only, and require a small allowance to be made when used for photography, so as to bring the surface of the plate into the position of sharpest focus. Supplementary lenses for effecting this correction are sometimes fitted to telescopic objectives, and compensating eyepieces, or oculars, to microscopic objectives. Many objectives of both classes are now made especially for photography.

The projecting lens of an optical lantern or cinematograph is usually called the objective.

The focal lengths of the microscope objectives in general use range from 3 in. to $1\frac{1}{2}$ in., but lenses of both lower and higher powers are manufactured. These figures refer to the equivalent focal lengths and not to the distance of the lens from the object when the latter is in focus.

Objectives of less than $\frac{1}{2}$ in. focus are almost invariably immersion lenses; that is, a medium, generally oil, fills the space between the front lens of the objective and the cover slip over the object; by using in this way a medium of higher refractive index than air, a higher numerical aperture, and consequently increased definition, can be obtained. In some older types of lenses water was the immersion medium, but cedar oil is now almost universally used, as it is of practically the same refractive index as crown glass. The depth of focus given by microscope objectives, which is of more importance for photographic than visual work, is extremely limited, especially with high powers. The penetration or depth of focus of a lens is approximately $\frac{1}{10}$ of its focal length; thus the penetration of an objective of $\frac{1}{10}$ in. focal length would be about $\frac{1}{100}$ in. In photomicrography the depth of focus would be considerably less than this, but stops can be placed in low-power microscope objectives to increase the depth of focus, and when thick sections

or specimens are photographed, this plan is often necessary.

In microscopy the magnifying power of a lens refers to the number of diameters by which the image given by the objective at a distance of 10 in. from the back lens magnifies the object; this is easily estimated when the focal length is known, as an objective of 1 in. focal length gives a magnification of ten diameters at a distance of 10 in. from the lens; therefore, a $\frac{1}{10}$ in. objective would magnify 60 diameters at the same distance. These figures represent the magnifying power of the objectives without the eyepiece, and are termed the initial power of the lens. When an eyepiece is used, the initial power of the objective multiplied by the magnifying power of the eyepiece, gives the total magnification of the lenses.

The resolving power of an objective—that is, the number of lines per inch which the lens will separate or resolve—does not depend upon its magnification, but upon the numerical aperture (*which see*), and a lens with a high N.A. will give better definition than a lens of higher magnifying power with a lower N.A.

Objectives with high N.A. have a small working distance between object and lens, and consequently less depth of focus. In photomicrography a good working distance and depth of definition are often extremely useful, and on this account an objective of high N.A. is not always desirable.

The best type of objective is known as the apochromat, which is expensive, and in practical work but little superior to first-class achromats, especially when colour filters are used. All modern objectives are fitted with the R.M.S. screw, that is, the worm at the back of the lens which is screwed into the body tube always has the same number of threads per inch, and any objective can be used with any microscope

OIL LAMPS (*See* "Dark-room Lamp.")

OIL TESTER (*See* "Acrometer" and "Oleometer.")

OIL OF VITRIOL (*See* "Sulphuric Acid.")

OILED NEGATIVES (*See* "Paper Negatives.")

OIL-OZOBROME (*See* "Ozobrome, Oil.")

OIL-PAINTINGS, PHOTOGRAPHING (*See* "Paintings, Photographing.")

OIL-PIGMENT PROCESS

A method of producing prints in pigment or ink applied with a brush. As contact printing is an essential part of the process it follows that an enlarged negative must be made before

such a print can be obtained of a subject originally taken on a small plate. It was to obviate this that the bromoil process was evolved. The steps preceding the actual pigmentation are few and simple. Special paper made for the purpose may be obtained, but a variety that is perfectly satisfactory is that supplied for the final support in the double-transfer carbon process. In any case it is simply a paper coated with gelatine. This has to be sensitised. It should then be stored in a calcium tube, but it is preferable to use it the next day if possible, so that it is best only to sensitise such quantities as are wanted for immediate use.

A 10 per cent. solution of potassium bichromate is an effective sensitiser. It should be applied by means of a Blanchard brush (see "Brushes"). Equal quantities of potassium bichromate solution and of methylated spirit are placed in a clean porcelain dish, which is tilted so that the solution lies at one end. One ounce of each is more than sufficient for half a dozen 12 in. by 10 in. sheets. A piece of the paper is laid face upwards on a pad of folded newspaper, and the brush is charged with solution and drawn across the paper first in one direction and then at right angles to it. Only enough solution should be taken to cover the surface. The stroking action in two directions is continued until the streaks on the surface practically disappear as the gelatine absorbs the sensitiser. The sheet is then pinned up, by one corner only, to dry, and the other sheets treated similarly. The sensitising should be done by a yellow light that would be fairly safe for bromide work, and the drying completed in the dark-room. When dry, the sheets may be placed in a box or tube, and should be protected from actinic light with the same care as in the case of platinotype paper. In fact, the paper resembles platinotype in its sensitiveness to light, and in the character of the image that prints out under the negative. Printing is continued until all that is required in the finished print is visible.

The prints are now washed in several changes of water. The yellow bichromate stain first disappears, but washing should be continued until there is practically no trace of colour even in the darkest shadows. In cold weather the temperature of the later washing waters should be raised to 60° or 65° F. (15.5° or 18° C.). The paper finally shows the subject as a gelatine relief, the high lights appearing considerably raised. Pigmenting may be proceeded with at once, or the prints may be dried and stored away for future treatment. In the latter case it is only necessary to re-soak the prints until the relief is again evident. For the method of finishing the print, see the outline of procedure given under the heading "Pigmenting."

OLEOMETER (Fr., *Oleomètre*; Ger., *Oleometer*)

Another name for the acrometer, a form of hydrometer specially graduated for testing the specific gravity of oils.

OMNICOLORE PLATE

This is a screen colour plate of French manufacture, the patent of Ducos du Hauron and De Bercegorol. By means of a printing

machine two lines in greasy ink are printed on gelatinised glass at right angles to one another, thus leaving little rectangles between the lines of gelatine, which is alone permeable to aqueous dye solutions. A compensating yellow screen or filter is used with the plates, and this and the filter elements reduce the speed of the emulsion to about 2½ Watkins, 1.7 H. and D., or 27 Wynne.

It is advisable to manipulate the plates in the dark, and they must be placed with the glass towards the lens and a piece of opaque card in contact with the film to prevent it from being injured. The compensating filter should be placed behind the lens and the ground glass reversed, or with fixed-focus cameras the insertion of the screen behind the lens sufficiently lengthens the focus for ordinary purposes. The developer recommended is:—

Metol	. . .	36 grs.	4 g.
Sodium sulphite			
(anhydrous)	. . .	1 oz.	50 "
Hydroquinone	. . .	18 grs.	2 "
Potass. carbonate (dry)	264 "		30 "
Potassium bromine	. 8½ "		1 "
"Hypo" sol. (1:1000)	145 mins.		15 ccs.
Distilled water to	. 20 oz.		1,000 "

Development should be continued for five minutes, the plate washed for 15 to 20 seconds, and then immersed in the reversing bath of—

Potassium or sodium			
bichromate	. . .	70 grs.	8 g.
Sulphuric acid	. . .	114 mins.	12 ccs.
Distilled water to	. 20 oz.		1,000 "

In which it should be left for about two minutes with gentle rocking. If a negative is required, naturally the plate is fixed after the first development and not reversed. If a positive is required, then the plate in the bichromate bath should be taken out into daylight for three or four minutes, or for five or six minutes to artificial light, and as soon as the whole of the image is dissolved, immersed in a 5 per cent. solution of bisulphite lye or metabisulphite, or 20 per cent. solution of sodium sulphite. The plate should then be re-immersed in the developer for five or six minutes, and when sufficiently dense, washed for about 30 seconds and fixed in—

Sodium hyposulphite	2½ oz.	125 g.
Sodium metabisulphite	. . .	265 grs.
Water to	. 20 oz.	1,000 ccs.

Next wash for 20 to 30 minutes in running water, dry, and varnish with a 15 per cent. solution of mastic or dammar in benzole.

Under-exposed or too dense pictures may be improved by reducing in a "hypo" and ferri-cyanide reducer; or weak pictures may be intensified with mercuric chloride followed by sulphite.

OPACITY (Fr., *Opacité*; Ger., *Schwarzung*)

The optical property of a substance, such as silver, to impede the passage of light through it. In sensitometry it is termed—

$$O = \frac{I_0}{I} = \frac{\text{Intensity of incident light}}{\text{Intensity of transmitted light}}$$

Thus, if we assume the intensity of the incident

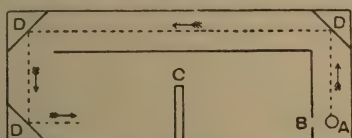
to be 1 and that of the transmitted light $\frac{1}{4}$, obviously $\frac{1}{\frac{1}{4}} = 4$, which is the opacity of silver that reduces the light to one-fourth.

OPACITY BALANCE

An instrument devised by Chapman Jones for measuring the opacities of bromide prints and other surfaces.

OPACITY METER

There are various instruments for measuring the opacities of negatives, etc., such as spectrophotometers, polarisation photometers, the modified Bunsen photometer of Hurter and Driffeld, and the Chapman Jones opacity meter. In the last named (*see* the diagram) an



Opacity Meter

incandescent gas light shines through aperture B upon an Abney screen C, a beam also being carried round the velvet-lined tube (by means of the mirrors D) to illumine the translucent part of the screen to which a negative is clipped. As a rule, in practical sensitometry (*which see*), the logarithms of the opacities are termed "densities" and are plotted.

OPALINES

Photographs mounted under glass and then upon plush or other supports. The glasses and all other necessary materials are supplied by dealers. A print, preferably P.O.P., is mounted, while wet, face downwards upon the cleansed bevelled glass; it may or may not have been treated with formaline or other hardening solution. For mounting, use $\frac{1}{4}$ oz. of gelatine in 5 oz. of water, allowing this to stand for a time, and then melting by gentle heat. Strain the warm gelatine solution through muslin into a flat dish, and while still warm soak each print in it bodily for about a minute and transfer, face downwards, to the glass, avoiding air bubbles. Should bubbles form, slide the wet print nearly off the glass and then back again over the edge, or roll the print with a rubber squeegee. If the original gelatine of the print is soft, no additional gelatine mountant may be necessary. The edges of the print should be flush with those of the glass, but when there is a gilt border, the print may be a trifle smaller. If desired, an ungilt, plain, bevelled glass may be used, the print being of such size as to leave a margin of clear glass all round; a backing of white or coloured paper can then be applied.

OPALS, OR OPALOTYPES (Fr., *Opales*; Ger., *Opals*)

Photographs may be transferred to opal glass by the carbon process, or the opals sensitised (or bought ready prepared) and printed upon direct, exactly as when using bromide paper. To ensure a perfectly clean and even

border, use a printing frame a size larger than the opal, and prepare a suitable mask having a clean-cut opening. Place a piece of cleaned glass in the frame and upon it the negative. Then, in a good light, place the mask in a suitable position on the film side of the negative, being careful not to move it when it is once in position. By the light of the ruby lamp, place the sensitive opal over the mask in such a way that the image, as seen through the mask, is in the centre, and that the margin of the opal, covered by the mask, is even. Put on the back of the frame, expose, develop, and finish.

For vignetted opals, use artificial light, and place an ordinary vignetter about $\frac{1}{4}$ in. in front of the frame; then expose to a weak light, such as that of a match or a candle, moving the light so as to soften the vignetting effect. To assist in securing clean margins, use fresh developer; but if stains or markings appear, clean them off with the iodine-cyanide reducer. After fixing and drying, coat with crystal varnish.

OPAQUE, OR OPAQUE PIGMENT

A blocking-out material for use on negatives, and consisting of any mixture sufficiently opaque to prevent the light acting through the covered parts of the negative. Brunswick black and red water-colour paint, such as Indian red, are largely used, the latter when working on the film side of the negative, because of the ease with which it may be washed off with water. For the glass side, use Brunswick black, or the following:—

Turpentine	.	.	$2\frac{1}{2}$ oz.	250 cc.
Asphaltum	.	.	$\frac{1}{4}$ "	28 g.
Beeswax	.	.	40 grs.	9 "
Carbon black	.	.	20 "	45 "

Mix well and apply with a brush.

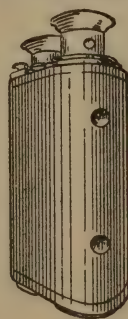
OPEN APERTURE (*See* "Aperture.")

OPEN LANDSCAPE

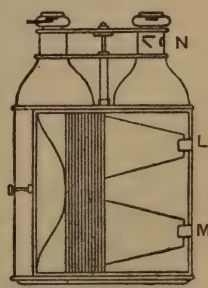
A view in which there is no near foreground; for example, that seen from an elevated spot.

OPERA-GLASS CAMERA (Fr., *Chambre lorgnette*; Ger., *Opernglas-kamera*)

A camera resembling an opera- or field-glass, and so designed that it may be worked while



A



B

Opera-glass Camera

held close to the eye. A illustrates a modern pattern of stereoscopic binocular, which permits

the pictures to be taken at a right angle to the direction in which the glass is ostensibly pointed. The two concealed lenses of the camera are at I, and M, while one eyeglass, N, acts as a finder by means of a mirror inclined at an angle of 45° , as shown at B, a sectional view of the apparatus. The camera takes a dozen plates in a magazine.

OPHTHALMOMET LENS

A biconvex fluid lens patented in 1905 in Germany. It worked at $f/9$.

OPTICAL AXIS

A straight line joining the centres of curvature of a spherical lens is called the principal optical axis. In the case of a lens having one plane surface, the principal axis passes through the centre of curvature of the spherical face and is perpendicular to the plane face. It is, of course, highly necessary in combining glasses to form a photographic lens that the principal optical axes should be absolutely coincident.

A straight line passing through the optical centre of a lens, and making with the principal axis a more or less large angle, is called the "secondary axis."

OPTICAL CENTRE

The point at which rays passing through a lens cross each other. It is only in the case of a symmetrical lens that the mechanical and optical centres coincide. According to the form of the lens and the position in which it is placed, the optical centre may be within the lens, or considerably before or behind it. It is often stated that the focal length of a lens should be measured from its optical centre, but this is not correct; the point measured from should be the node of emission.

OPTICAL CONTACT

The condition existing when the surfaces of two pieces of glass, or those of a piece of glass and another substance, are in such intimate contact that all air is excluded. Under these conditions the surface of the glass that is in optical contact with the other substance, or the two glass surfaces that are in contact, cease to reflect light. But light is reflected by an opaque substance in optical contact with glass. Backing on a dry plate must be in optical contact if it is to be efficient; hence a piece of black velvet or paper at the back of a plate, sometimes advocated as a substitute for backing, is of small efficiency. The various glasses which form the combinations of a lens are cemented together in optical contact by means of Canada balsam. Prints are sometimes mounted in optical contact with glass, producing a very brilliant result. Prints on albumenised paper and on collodion emulsion paper, do not require preparation; but those on gelatine printing-out or on bromide or gaslight papers should be hardened in a bath of formaline 1 part and water 10 parts. The glass that is to receive the print must be thoroughly clean and, after slightly warming, should have a solution of gelatine (about 15 grs. per 1 oz. of water) poured upon it. A print is laid face down on the gelatine, and squeegeed into contact so as to expel most of the gelatine and all the air.

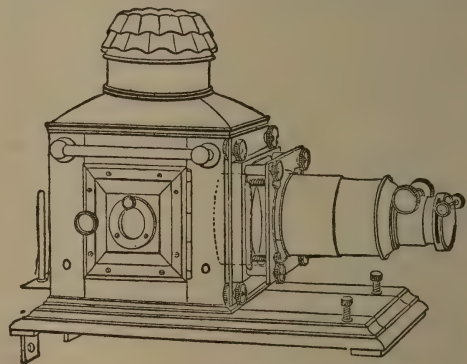
OPTICAL GLASS (See "Glass.")

OPTICAL INTENSIFICATION

A process for obtaining an intensified negative without the employment of chemical intensification. The details of a thin negative may be more plainly seen if the negative is laid film side downwards upon white paper, the light being reflected through the negative and giving the same effect as if two identical negatives were superimposed and held up to the light. A thin negative so backed is copied in the camera and the resultant positive is, in turn, copied (backed up with white paper as before), or a negative is made from the positive by direct contact. Lord Rayleigh, in 1897, recommended backing up a thin negative with mercury, or with a flat, polished reflector, and illuminating in a special way, but the process first named above gives as good results.

OPTICAL LANTERN

An appliance, popularly known as the "magic lantern," by means of which transparencies are optically projected by artificial light upon a screen, the diameter of the image being thereby increased by from 24 to 150 times. The enlarging lantern (*which see*) is an optical lantern, but the increase in the size of the image rarely exceeds from 20 to 30 times, and is generally much less. An optical lantern comprises a body, an illuminant, an optical system, and means for holding the transparency (slide) in the path of the light. The body may be of wood or metal, the former (generally mahogany) being the stronger, and the latter being the lighter, and therefore having advantages from the point of view of portability. A typical high-class lantern having a wooden body is here illustrated. There should be a door on one or both sides, and a close-fitting cowl or crinkle as light-tight as possible. When an oil-lamp is the source of light, the chimney projects at the top. The



Optical Lantern with Wooden Body

illuminant (*see* the next article) is supported by the body in line with the optical axis of the lenses, and the lamp or jet is mounted on a metal plate or in a metal tray, which slides in grooves formed in the lantern body, it being necessary to provide for adjusting the distance between the condenser and the illuminant. The condenser, consisting in its commonest

form of two plano-convex lenses mounted in a brass cell with the convex surfaces facing each other (see "Condenser"), collects the light rays and causes them to illuminate the transparency evenly; thence the rays pass to the objective lens, which projects them upon the screen. (For a diagram explaining the optical principle involved, see "Condenser.") The objective is a lens of the Petzval portrait type (see "Lens"), but it is not wise to use it for photography, as its visual focus may not coincide with the actinic focus. The draw-tubes in the front of the lantern, and the rack and pinion on the jacket of the objective tube, allow of proper focusing. Frequently, in front of the lens mount is a "flasher," consisting of a hinged or pivoted disc serving as a lens cap. The transparency, carried in a wooden slide carrier having a to-and-fro movement, is inserted into the stage of the lantern immediately in front of the condenser, the carrier being held in place by a spring plate.

To shield the audience from stray light rays, it is usual to fit a heavy curtain to the back of the lantern.

A "single" lantern has but one illuminant and optical system; a "biunial" has two, one above the other; and a "triunial" (now but rarely used) has three. When oil is the illuminant it is necessary to have the systems (actually separate lanterns) side by side. Biunial and triunial lanterns were much used in earlier days for the production of the then popular dissolving views (*which see*).

The screen may be a white sheet, or a plastered wall painted "flat" or "dead" white. Collapsible frames for sheet screens are commercial articles. When the lantern is behind the screen and the audience in front, the screen should be wetted to make it more translucent, and the slides should be inserted into the carrier with the fronts facing the screen. Ordinarily, when both lantern and audience are in front of the screen, the slides are inserted upside down, but unless they have been carefully "spotted" beforehand (see "Lantern Slides, Masking, Binding, and Spotting"), some of them are sure to be shown upside down on the screen. The lanternist should accept unspotted slides only at the lecturer's risk.

In connection with the calculation of the size of the disc on the screen, of the distance of the lantern from screen, or of the focal length of the lens to be employed, it should be said that the use of a set of interchangeable objectives renders the lanternist largely superior to the difficulties frequently caused by particularly small or large halls, and by the inconvenient placing of pillars, lights, etc., in the building.

The size of the disc of light projected by a lantern upon a screen depends upon the focal length of the lens and the distance between lantern and screen. Assuming the diameter of the slide to be 3 in., the size of the disc under certain conditions is found by multiplying 3 by the distance (in feet) between lantern and screen and dividing by the focal length of the lens in

inches. Thus, at a distance of 40 ft., a 7-in. lens gives a picture more than 17 ft. in diameter, as $\frac{3 \times 40}{7} = 17\frac{1}{7}$. To determine the focal length

of lens necessary under certain conditions, multiply 3 by the distance and divide by the diameter of the desired disc. Thus, at a distance of 24 ft., and to produce an 8-ft. disc, a lens of 9-in. focal length would be necessary, as $\frac{3 \times 24}{8} = 9$. To determine the distance at

which a given lens will produce a given disc, multiply the focal length by the diameter of the disc and divide by 3. Thus, a 9-in. lens would produce a 10-ft. disc at a distance of 30 ft., as $\frac{9 \times 10}{3} = 30$. A simple calculation on the

lines of the above saves the lanternist the trouble of trying different lenses or of shifting his apparatus.

The "opaque" lantern—that is, a lantern for projecting images of opaque objects—is described under the heading "Aphengescope."

OPTICAL LANTERN ILLUMINANTS

Given in the order of their efficiency, optical lantern illuminants include the oil-lamp, incandescent gas, acetylene, limelight, and the arc lamp. Metallic filament electric incandescent lamps are also used occasionally, but these share with the oil-lamp and incandescent mantle the disadvantage of the light being emitted by a relatively large surface instead of coming from a point, or, at most, a spot. The oil-lamp becoming more and more a thing of the past. It has two, three or four wicks, and much of the light emitted by it is wasted; in addition, if not kept scrupulously clean it is smelly, many patterns are liable to smoke, and the heights of wick and chimney are matters for careful adjustment. The incandescent gas mantle is much more cleanly in use, but the illumination is not much increased, and the mantle, after one use, is very fragile. Acetylene (*which see*) gives a much more intense light than either oil or incandescent gas, but it needs a generator, to the employment of which many people have objections, but which, if of reliable make and properly used, is a perfectly safe device; the use of compressed (actually dissolved) acetylene, obtainable in cylinders, opens up possibilities where the light itself is preferred, but the generator objected to. Limelight (*which see*) was, until quite recent years, the most popular and the most generally convenient illuminant, but in all places where electric current is available it must now give place to the arc lamp (*which see*). Lantern arc lamps are generally of the hand-feed type, it being necessary to adjust the distance apart of the two carbons as they burn away, as otherwise the unequal consumption would cause the arc to shift its focus and the illumination of the image to suffer. For low powers, the Nernst electric lamp has proved useful.

OPTICAL SENSITISERS

Dyes which have the property of modifying colour sensitiveness. Treatment of a sensitive photographic film with certain dyes in solution has the effect of increasing its sensitiveness

to different regions of the spectrum; thus eosine or erythrosine will make an "ordinary" plate sensitive to yellow, as in the original isochromatic plate of Tailler and Clayton, while cyanine increases the sensitiveness to red. The dyes may be added to the emulsion before coating the plate, or a finished plate may be bathed in the solution. The latter procedure is generally adopted in the case of panchromatic plates. (See also "Colour Sensitising," "Isochromatic Plates," etc.)

OPTICS (See "Lens" and various other headings.)

ORANGE BICHROMATE

A synonym for potassium bichromate.

ORANGE LIGHT

Orange light for dark-room illumination was in general use before the introduction of dry plates, for which, however, it was found not to be sufficiently safe, and ruby light was substituted. Orange or yellow light (light filtered through orange- or canary-coloured fabric or glass) may safely be used for most of the modern bromide papers and lantern plates and also for very slow plates. (See also "Canary and Orange Medium.")

ORDOVERAX

A proprietary name for a process of reproducing line drawings; the process is allied to ink printing (*which see*). A clean, flat zinc plate is coated with a colloid of special composition; an exposed but undeveloped blue-print (made from the drawing) is then laid downwards on the plate for a moment and removed. The parts that were in contact with the unexposed lines of the blue-print will now take ink from a roller, while the ground repels the ink. The plate is inked, and paper, cloth, etc., is pressed into contact to produce an excellent reproduction of the original drawing.

ORGANIC COLOURS

A term applied generally to aniline colours to differentiate them from colours obtained from inorganic or metallic sources.

ORGANIFIER

A preservative applied to the sensitive surface. The word is used more frequently than preservative. The organifiers or preservatives recommended in the early days of the collodion process (about 1864) were solutions or infusions of tannin, gum, tea, coffee, beer, tobacco, and albumen, and also sherry wine. (See also "Ceramic Process.")

OROHÉLIOGRAPH (Fr., *Orohéliographe*; Ger., *Oroheliograph*)

A panoramic camera designed by Noe for taking photographs of the whole visible horizon. The lens points upward to the sky, the plate being beneath it in a horizontal position. Above the lens is adjusted a convex paraboloid mirror—that is, a mirror of circular cross-section and parabolic vertical section. This mirror reflects a view of all surrounding objects downward to the lens, which forms a circular image on the plate.

The arrangement much resembles that adopted in some forms of periscopes for submarines. Such views, though distorted, are useful for checking surveying and photogrammetric observations.

ORTHOBORIC ACID (See "Boric Acid.")

ORTHOCHROM T (Fr. and Ger., *Orthochrom T*)

Synonym, *p*-toluchinaldin-*p*-tolucholinethylocyanine-bromide. Soluble in water and alcohol. One of the isocyanine dyes introduced by the Hoechst Dye Works as a sensitiser. It is most satisfactory, giving with reasonable exposures a closed band from the blue to the D lines; that is, it sensitises for blue-green, green and yellow, with a much less marked drop in the blue-green than erythrosine, but with practically no red sensitiveness. The best results are obtained by bathing the plates in—

Orthochrom T solution (1 : 1,000)	. 192 mins.	20 ccs
Distilled water to	. 20 oz.	1,000 "

for three to four minutes, and then rinsing and drying. These operations must be conducted in the dark or in a very faint red light. By replacing one-third of the above quantity of water with alcohol, clean-working and quicker-drying plates which do not require rinsing are obtained.

ORTHOCHROMATIC (See "Isochromatic.")

ORTHOCHROMATISM

The quality possessed by plates that are sensitive to parts of the spectrum besides the violet and blue. Practically synonymous with isochromatism, and fully treated under the headings "Colour Sensitising," "Isochromatic Plates," etc.

ORTHODIHYDROXYBENZENE

A synonym for pyrocatechin.

ORTHOGRAPH AND ORTHOGRAPHIC LENSES

Names given at one time to lenses of the rapid rectilinear (doublet) type. (See "Lens.")

ORTHOHYDROXYBENZOIC ACID

A synonym for salicylic acid.

ORTHOMETHYLAMIDOPHENOL

One of the constituents of ortol.

ORTHOSCOPIC LENS

A rapid rectilinear doublet lens. (See "Lens.")

ORTHOSTIGMAT LENS

A series of cemented anastigmats introduced by Steinheil, of Munich, and manufactured in England by Beck. They were made with initial intensities of $f/6.3$ and $f/6.8$, and were convertible, the single lens having an aperture of $f/12.5$; in addition there was a rapid wide-angle lens (nearly 110°) with an intensity of $f/11.3$.

ORTOL (Fr. and Ger., *Ortol*)

Hauff's developer, containing orthomethylamidophenol, $C_6H_4(OH)NHCH_3$, and hydroquinone



GROUP OF INSECTS' EGGS

BY J. I. PIGG, F.R.M.S., F.R.P.S.

PHOTOMICROGRAPHY

introduced from Germany in 1897; in character, intermediate between metol and pyro-soda. It is a yellowish-white crystalline powder, very soluble in water, with which it forms a colourless solution which gives a blackish image. It will not work alone; combined with sodium sulphite it works very slowly, some hours being required to produce an image; but in conjunction with sodium or potassium carbonate it forms a steady working developer, with a factor of 10. It is suitable for all dry plates, lantern plates, and bromide and gaslight papers. When properly used, it does not stain the negative, but when ammonia or acetone is used, or sulphite is added to the ortol solution, a reddish stain sometimes appears. The use of metabisulphite and of a carbonate, however, tends to prevent staining, but should it appear it may often be removed with methylated spirit.

Ortol may be used in a one- or, preferably, two-solution form:—

One-solution

Ortol	80 grs.	9 g.
Potass. metabisulphite	20 "	2.25 "
Sodium sulphite	2 oz.	110 "
Potassium carbonate	640 grs.	73 "
Potassium bromide	4 "	.5 "
Water	20 oz.	1,000 ccs.

This is best made up as required, the ortol and metabisulphite being dissolved in one half of the water, the remainder of the chemicals in the other half, and the two solutions mixed together.

Two-solution

A. Ortol	140 grs.	16 g.
Potassium metabisulphite	70 "	8 "
Cold water	20 oz.	1,000 ccs.
B. Sodium carbonate	2½ oz.	138 g.
Sodium sulphite	2½ "	138 "
Water	20 "	1,000 ccs.

or—

B. Potass. carbonate	1 oz.	55 g.
Sodium sulphite	2½ "	138 "
Water	20 "	1,000 ccs.

Use equal parts of A and B.

If a restrainer is needed, add a few drops of a 10 per cent. solution of potassium bromide, or embody the bromide in the developer when making it by adding to either of the B solutions from 8 to 16 grs. per 20 oz. (1 to 2 g. per 1,000 ccs.). A weak solution of "hypo" has been recommended as a restrainer, but it needs to be used with great caution. A 10 per cent. solution of a caustic alkali may be used as an accelerator in cases of under-exposure. By increasing the proportion of A, harder negatives will be produced; and the converse also holds good. A lower temperature than 66° F. (19° C.) will retard development, and during very cold weather the potassium bromide may with advantage be omitted. The high lights of the image appear normally in from 20 to 30 seconds, and then the half-tones and shadows, the density being added at the same time; development is usually complete in from four to five minutes.

OUNCE

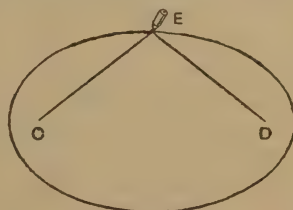
In apothecaries' weight (by which formulæ are made up), 480 grains, or one-twelfth of a pound; 31.106 grammes. In avoirdupois weight (by which chemicals are bought and sold), 437½ grains or one-sixteenth of a pound; 28.4 grammes. In fluid measure, 480 minims, or one-twelfth of a pound; 28.4 cubic centimetres (See also "Weights and Measures.")

OVALBUMEN

A synonym for egg albumen.

OVALS, MARKING AND CUTTING

The so-called oval seen in photographic cut-out mounts is strictly an ellipse, an oval being really egg-shaped. The easiest way of marking an ellipse is by means of two pins and a piece of string, as shown in the illustration. The pins, C and D, are stuck tightly in the cardboard to be marked, and a pencil, E, is placed in the



Marking an Oval

loop and moved round, keeping the string taut. This is done first on one side and then on the other, thus tracing an ellipse. If an endless piece of string is used, the ellipse can be drawn without withdrawing the pencil from the loop. The length (major axis) of the ellipse is always equal to that of the greatest stretch of the string, while the width (minor axis) depends on the distance apart of the pins and may be regulated by a few trials. It is preferable to mark the ellipse on a sheet of thin metal, using this as a template and keeping it for future use. For cutting the mount a mount-cutter's knife is employed, but a keen penknife may be used.

A machine has been constructed for the use of process workers for cutting and marking ovals. Any dimension may be obtained by shifting the bed out of the centre, and also by shifting the tool along the bar. The former movement registers the difference between the major and minor axes of any determined oval, whilst the latter movement sets the tool to the major axis.

OVEN, DRYING (See "Drying Box or Cupboard.")

OXALATE DEVELOPER

Better known as the ferrous oxalate developer (*which see*).

OXALIC ACID (Fr., *Acide oxalique*; Ger., *Oxalsäure*)

$C_2H_2O_4 \cdot 2H_2O$. Occurs in colourless and odourless prisms with strong acid and bitter taste. Solubility, 12 per cent. in cold and 100 per cent. in hot water; insoluble in alcohol.

It is used in the sensitising of platinotype paper, and as a preservative for the pyro developer, from 2 to 3 per cent. being used. It is very poisonous, the antidotes being chalk or magnesia mixed with milk or water.

OX-GALL

The purified and evaporated gall of the ox; used when tinting prints with water colours in order to overcome the greasy or repellent surface of the print. The gall is purchased either in a solid form, or as an evil-smelling sticky mass. A small quantity of it is dissolved in warm water, and when cold brushed over the print and dried. It was used largely in the days of albumen prints, for which it is particularly suitable.

In process work, ox-gall is used for preparing the surface of glossy prints for taking the retouching colours, or for admixture with the colours. It is also sometimes used in blocking-out negatives for preventing the colour from running. It is used in collotype work for preparing the plate.

OXYCALCIUM LIGHT

An early name for the limelight.

OXYCHLORIDE OR OXYHALOID THEORY

The theory that the latent image consists of the oxychloride, oxybromide, or oxyiodide of silver. The objection to this theory is mentioned in the article under the heading "Latent Image."

OXYETHER LIGHT

A system of limelight in which oxygen, saturated with ether, is burnt in a jet to provide the heat for raising the lime to incandescence.

OXYGEN GAS FOR LIMELIGHT (See "Compressed Gas" and "Limelight.")

OXYHYDROGEN LIGHT (See "Limelight.")

OXYMAGNESIUM LIGHT

A system resembling limelight, but employing magnesium instead of lime. (See also "Magnesium Beads.")

OXYMEL (Fr. and Ger., *Oxymel*)

A mixture of honey and dilute acetic acid, used in the old collodion dry-plate days as a preservative.

OXYPHENYLGLYCINE

A synonym for glycine.

OYSTER SHELL MARKINGS

A defect met with in the wet-plate process, and caused by unequal drying.

OZOBROME

A method of producing carbon pictures from bromide prints, patented by Thomas Manly, in 1905. Its advantage is that it makes the worker independent of daylight. Bromide enlargements can be made for producing carbon pictures, thus saving the trouble and expense of making enlarged negatives. Whether the

carbon image is produced upon the bromide print or whether the pigment image is transferred to another support, the resulting picture is correct with regard to right and left. An ozobrome pigment plaster (paper coated with pigmented gelatine) is soaked in a bath of diluted ozobrome pigmenting solution, transferred to an acid bath for a few seconds, squeegeed to a wet bromide print and left for about twenty minutes for the insolubilising action to take place. The method of working is as follows: Place the bromide print in a dish of water, immerse the pigment plaster in the diluted ozobrome pigmenting solution until soft and limp (about one or two minutes), and then withdraw the plaster and immerse it for ten to fifteen seconds in a bath of—

Chrome alum (pure) .	36 grs.	16.5 g.
Bisulphate of potass.		
(cryst.) .	12 "	5.5 "
Citric acid .	5 "	2.3 "
Water .	5 oz.	1,000 ccs.

An immersion of, say, 20 seconds will produce a soft, delicate picture from a strong bromide print, and an immersion of, say, 7 to 10 seconds will give a strong, deeply-coloured picture from a weak and grey bromide print. For a good, well gradated bromide print, an immersion of from 12 to 15 seconds would be sufficient. After removal from the acid bath, the soaked pigment plaster is brought into contact with the bromide print lying in the dish of water. The two papers (clinging together) are quickly withdrawn, squeegeed together, and allowed to remain in contact for 15 to 20 seconds. One of two methods may then be selected to produce pigmented pictures. In the non-transfer method, the bromide print itself forms the support of the gelatine image. The adhering papers are plunged into water at about 160° F. (41° C.), the plaster backing is removed, and the development carried out as in the ordinary carbon process. In the transfer process the plaster and bromide print are separated in cold water, the pigment plaster carrying an impression of the image. The plaster is squeegeed to a soaked piece of transfer paper and left for 10 to 15 minutes, when the development is carried out in hot water in the usual way. The second method is preferable to the first one, as it yields a pure carbon picture with a choice of paper support, and leaves the bromide print, after redevelopment, available for further transfers.

OZOBROME, OIL

Oil ozobrome is a modification of bromoil. A bromide print is treated in such a manner that the altered image will retain greasy ink while the unchanged portions will repel it. A bromide print is bleached in the following bath:—

Ozobrome pigmenting solution .	1 oz.	30 ccs
Chrome alum acid bath	5 "	150 "
Sodium chloride (salt)	$\frac{1}{2}$ "	17 g.
Water .	4 "	120 ccs.

The bleached print is rinsed for a few seconds and transferred to a fixing bath of "hypo"

3 oz., and water 20 oz., where it should remain for five to six minutes. After washing for five minutes, the print may be inked up, but it is better to allow it to dry and then resoak for five to ten minutes in water at 65° to 70° F. (about 18 to 21° C.).

Oil Transfer Process.—In this process the resulting image will be reversed in regard to right and left; therefore, in enlarging, the negative should be reversed in the lantern. A sheet of ozobrome transfer paper is immersed in the bleaching bath specified above, whilst the bromide print is soaking in water. The transfer paper, saturated with the bleaching solution, is placed face upwards on a sheet of glass, and the wet bromide print carefully laid down upon it and squeegeed into contact. The bleaching takes from 10 to 45 minutes to complete, the progress of the action being easily observable by holding the adhering papers in front of a strong light. When bleached, the papers are separated and washed for about ten minutes until all yellow coloration has disappeared. The transfer paper, carrying a copy of the image, should be hung up to dry and the bromide print redeveloped. When dry the impressed transfer paper is soaked for 20 to 30 seconds in cold water, and after removing the superfluous water it is ready to ink up. The bromide print is available for further transfers.

OZONE BLEACH

A synonym for "Labarraque's solution" and "eau de Javelle."

OZOTYPE

A pigmented gelatine process, patented by Thomas Manly in 1899, differing from the usual carbon method. Sized paper is coated with a solution containing a bichromate and a manganese salt. This preparation is sensitive to light, and under a negative produces a positive image in manganese chromate. A pigment plaster (paper coated with pigmented gelatine) is soaked in an acidulated solution of a reducing agent, such as hydroquinone or ferrous sulphate, and applied to the washed image. The action of the acid produces chromic acid which is immediately reduced by the hydroquinone or ferrous sulphate, with the result that the gelatine is tanned. In practice, the ozotype process is carried out by coating well-sized drawing paper with the ozotype sensitising solution, thoroughly drying, and printing under a negative in daylight. The image is of a light brown colour and distinctly visible. When all details appear the image is carefully washed for a limited time,

as it is slightly soluble. A piece of pigment plaster is then soaked for 30 to 60 seconds in the following bath:—

Glacial acetic acid	. 50 mins.	4 ccs.
Hydroquinone	. 12 grs.	1 g.
Copper sulphate	. 12 "	1 "
Water	. 25 oz.	1,000 ccs.

As soon as the pigment plaster is quite limp the chromium print is expeditiously brought into contact with it in the bath, and both papers, clinging together, are withdrawn and squeegeed gently together. The adhering papers are left for 30 to 60 minutes for the action to take place, when they will be ready for development, which is carried out by separating the papers in water at about 110° F. (about 43° C.), and dissolving away all soluble gelatine. The advantages are (1) a visible image; (2) no reversal of the image; (3) almost unlimited control with the brush.

OZOTYPE PROCESS, GUM

The application of the ozotype principle to the production of images in pigmented gum was easily foreseen after the introduction of gelatine ozotype. The paper is prepared and the image obtained as in ordinary ozotype, but a rather stronger printing is required. A pigmented gum mixture is made up as follows:—

Water		2 parts
Gum arabic		1 part
Powdered colour		q.s.

Also make up the following acid reducing bath:—

Sulphuric acid	. $\frac{1}{2}$ drm.	10 ccs.
Copper sulphate	. 180 grs.	72 g.
Hydroquinone	. 60 "	24 "
Water	. 6 oz.	1,000 ccs.

The gum and pigment are worked and ground together with a palette knife on a sheet of glass, and about the same quantity of the acid reducing solution added. The mixture is pounded in a glass mortar, evenly spread over the image with a flat hog-hair brush, and finished off by means of a badger-hair softener. The coated paper is then allowed to dry slowly in a cupboard, in which a wet cloth is hanging with the object of keeping the atmosphere moist. When dry, the image is developed in cold or tepid water. The advantages of the process are: (1) A visible image; (2) the tanning action proceeds from the image upwards through the film of gum, resulting in the preservation of all detail; (3) the operation can be carried out in full daylight.

PACKHAM'S CATECHU STAINING (See "Catechu Toning.")

PACKING NEGATIVES FOR POST

The following is considered one of the safest ways of packing negatives to be sent by post. Put the bottom one film up and on it a sheet of clean white paper, then the next negative film side downwards, then another sheet of paper, and so on, all the negatives, except the bottom one, being film side down. Wrap the whole tightly in brown paper, and force into a plate box in such a way that the negatives cannot rub together. Tie tightly and wrap the box in a strip of corrugated paper, cut to the length of the box, and then in another strip cut to its width. In this way the corrugated folds are at right angles, and prevent twisting and breakage. Finally, wrap in brown paper and tie firmly. It is advisable to use a tie-on label.

PACKING PLATES

The question of packing—or, rather, re-packing—plates after exposure is of importance to the tourist. He should remember not to throw away the outer wrapper and the inner packings, as these will come in useful. The best way to remove the outer wrapper from a box is to cut across the centre all round with knife or pocket scissors, so that each half may then be slid off, as shown. When required, the two halves may



Plate Box Cut Open

be replaced and bound together with strips of gummed paper, thus making it practically impossible to open the box accidentally. Exposed plates should be placed film to film, and the pairs—usually six—wrapped in a solid block in brown or other opaque paper and pressed into the original box, using paper pads at the ends and sides of the box to prevent the plates rubbing together and shaking about loose in the box; the lid is then replaced, then the outer wrapper, and the whole tied with string or bound with gummed paper. It is a common practice to put pieces of paper between the film sides of the plates, but newspaper or other printed matter must not be used, because the printer's ink has an action upon the sensitive film and becomes transferred to the picture, invariably showing badly when the plate is developed. If the printer's ink is seen upon the plates before development, it may sometimes

be removed—in the dark-room, of course—by rubbing with benzene upon cotton-wool. Even when white paper is used between the plates there is a risk of fogged patches appearing, and cigarette papers have been known to fog plates very badly. It has been suggested that white paper possesses luminiferous or phosphorescent properties—extremely faint, of course, but sufficient, over a period of several weeks, to cause fogging. In spite of this, however, white paper is commonly employed.

Other errors in packing are due to ignorance of the fact that pressure will exert an influence upon the sensitive emulsion. An envelope containing an exposed plate is often written upon, and if the writing is done upon the side resting upon the film a reproduction will more often than not be found upon the negative. Should it be necessary to mark exposed dry plates, the writing should be done in very small characters on one of the extreme corners of the film side.

PAINTINGS, PHOTOGRAPHING

The general principles to be observed in photographing paintings are given under the heading "Copying," but the arrangement for holding the original and the camera so that the picture and the sensitive plate are parallel cannot often be employed. Carefully ruled pencil lines on the focusing screen, forming perfectly true rectangles, will assist in avoiding inaccuracy. Glass should always be removed from glazed paintings, if possible, it being so difficult to kill reflections entirely. When the glass may not be removed, a black screen should be hung immediately behind the camera, and the last-mentioned should be covered with a black cloth; or the screen should be hung close in front of the camera, with a small aperture through which the lens may project. Folds or undulations in the surfaces of screen and cloth should be avoided, so that the picture reflects only a uniformly dark mass. A lens of long focal length is preferable, it being then easier to avoid the sheen on an oil painting interfering with the rendering. In the case of water-colour drawings, the chief consideration is that the lens should cover the plate with crisp definition, and the proportion of focus to plate is immaterial.

After the image has been focused, the lens and focusing screen should be removed and the picture examined through the lens opening from the back of the camera. In the case of an oil painting without glass this examination determines whether sheen on the surface is visible; in the case of a picture under glass, it shows whether reflections are destroying the image. Sheen or reflections at the top of a picture can frequently be avoided by raising the camera; those at either side can be obviated at times by means of a screen.

Isochromatic plates should be used for this work, together with a yellow screen or light filter. A green screen is an advantage with some subjects. (*See also "Monochrome, Rendering Colours in."*) The screen should be used behind the lens when possible, and the final focusing should be done with the screen in position.

The exposure must be gauged by the aid of a meter held with its back flat against the picture. For an oil painting in good, bright condition, using a plate of the speed of 200 H. and D., and a lens aperture of $f/16$, the exposure should be half the time necessary for matching the meter tint in the case of a Wynne meter, or one-fourth the meter tint in the case of a Watkins meter. For an old or very dark picture, from twice to three times this exposure will be necessary. For a water-colour drawing the exposures will be shorter. For a very dark or solidly painted picture the exposure will be about one-third the meter tint of a Wynne meter, and one-sixth that of a Watkins, using the same plate and lens aperture as given above. For a light and delicate sketchy drawing these exposures may be reduced to one-eighth of the Wynne meter tint, and one-sixteenth of the Watkins. All the above exposures are those necessary without a colour screen or light filter; and they must be multiplied by the number of times extra exposure that the screen necessitates. They are all given for copying the same size as the original, the lens aperture being that marked $f/16$ on the diaphragm scale, and not calculated from the extra extension. Proportionate exposures for other scales will be found under the heading "Copying."

PALLADIOTYPE (Fr., *Palladiotype*; Ger., *Palladiotypie*)

A printing process resembling platinotype, but employing palladium instead of platinum; originated by Alleyne Reynolds.

PALLADIOUS CHLORIDE (Fr., *Chlorure de palladium*; Ger., *Palladiumchlorid*)

Synonyms, palladium chloride, dichloride of palladium. PdCl_2 . Molecular weight, 177.5. A dark brown mass or powder, very deliquescent, obtained by the action of aqua regia on palladium. Occasionally used for toning prints.

PALLADIOUS POTASSIUM CHLORIDE (Fr., *Chlorure de palladium et de potasse*; Ger., *Kaliumpalladiumchlorid*)

Synonyms, chloropalladinite of potash, palladium and potassium chloride. $\text{PdCl}_2 \cdot 2\text{KCl}$. Molecular weight, 326.5. Solubilities, soluble in water, slightly soluble in alcohol. Prismatic crystals obtained by adding potassium chloride to a hot solution of palladious chloride. They are dichroic—that is, they appear red or green as seen across or along the axis. Occasionally used for toning prints.

PALLADIUM (Fr. and Ger., *Palladium*)

Pd. Atomic weight, 106.5. A silvery white, hard, but ductile metal, obtained from its ores. Used to prepare the chlorides which enter into a few toning formulæ.

PALLADIUM TONING (Fr., *Virage à palladium*; Ger., *Schönen mit Palladium*)

Palladium toning is expensive and has no advantages over gold and platinum toning. It gives tones of various shades of brown. The print is reduced slightly, and loses a little colour in the fixing bath; allowances must therefore be made. For ordinary P.O.P. the bath is:—

Palladious chloride	. 2 grs.	.45 g.
Sodium chloride	. 20 "	4.5 "
Citric acid	. 20 "	4.5 "
Water	. 10 oz.	1,000 ccs.

The sodium chloride (salt) may be omitted from the bath if desired, in which case the prints should be washed in a weak solution of salt in water before toning. The salt ensures the conversion of any free silver remaining in the paper, although it retards the toning action, and sometimes is apt to stop it entirely. It is also advisable to put the prints after toning in a bath of $\frac{1}{2}$ oz. of common soda in 20 oz. of water in order to neutralise the acid and prevent sulphur toning, afterwards fixing and washing in the usual way.

A toning bath for plain salted paper, giving tones similar to those of platinum, is:—

Palladious chloride	. 1 gr.	.22 g.
Sodium sulphite	. 60 grs.	13.5 "
Water	. 10 oz.	1,000 ccs.

Use as above.

For chocolate-brown tones on glossy papers Mercer advises:—

Palladious chloride	. 1.6 grs.	.36 g.
Ammonium molybdate	. 16 "	3.6 "
Citric acid	. 16 "	3.6 "
Water	. 10 oz.	1,000 ccs.

For matt papers, substitute common salt for the molybdate. The fixing bath must be distinctly alkaline.

PANAPLANATIC

A term applied to a lens exceptionally free from spherical aberration. A microscope condenser by Swift is sold under this designation.

PANCHROMATIC LENS

A lens corrected for the secondary as well as the primary spectrum, and therefore suitable for use in three-colour work. (*See also "Apochromatic."*)

PANCHROMATIC PLATES

Plates made sensitive to the entire spectrum, and used either for isochromatic photography with a suitable screen where a full colour rendering is required, or for colour photography by the three-colour process. They can be made by bathing slow ordinary plates with certain aniline dyes, particularly some of the isocyanine derivatives. Either of the two following baths is suitable for panchromatising:—

A. 1:1000 alcoholic solution of pinachrome	. 8 mins.	2 ccs.
Liq. Ammon. ('880)	4 "	1 "
Distilled water	. 400 "	100 "

B. 1 : 1000 alcoholic solution of homocol (Bayer)	. 12 mins.	3 ccs.
Ammonia (.880)	. 8 "	2 "
Distilled water	. 480 "	120 "

Instructions for bathing will be found under the heading "Isochromatic Plates." Particular care must be exercised as to cleanliness, pure air for drying, and rapidity of drying in the case of red-sensitive plates, as they are liable to fog on the least provocation. A truly panchromatic plate should be evenly sensitive to the whole visible spectrum, but with practically all plates there are "gaps" in the sensitiveness—that is, comparatively less sensitiveness towards certain regions, particularly the bluish-green—due to minima of absorption in the dyes used. Both pinachrome and homocol plates exhibit two minima in their spectrum sensitiveness, which can be filled up to some extent by the use of supplementary dyes.

Colour filters for either three-colour work or isochromatic photography must possess minima in their absorption spectra to compensate for any minima in the spectrum sensitiveness of the plates to which they are adapted.

Development should always be carried out with a cool solution, and in darkness or in a green "safe" light.

In process work, panchromatic dry plates are largely used for the three-colour process, the exposures being made directly through the colour filter and the half-tone ruled screen.

PANEL

A commercial size of photographic mount which accommodates whole-plate prints trimmed to panel shape, and measuring about 8 in. by 4 in. Therefore, ordinarily, a panel mount may measure about 9 in. by 5 in., but it may be much larger, according to the margin allowed; 13 in. by 7½ in. is a common size. "Large Panel" mounts measure about 17 in. by 10½ in.; "Grand Panel," 23 in. by 13½ in.; and "Paris Panel," 10 in. by 7½ in. There are also "midget panels," the term panel being somewhat loosely applied to any mount which is of panel shape.

PANEL LENS

A lens adapted for the production of panel-sized portraits. Any good portrait lens or anastigmat of about 20 in. focal length answers well for a 12-in. by 10-in. plate, if it covers it.

PANIKONOGRAPHY

Gillot's process of zinc etching. (See "Gillotage.")

PANNOTYPY, OR PANNOTYPE

A process of transferring a collodion negative film to a dark oilcloth, so that a positive effect is obtained.

PANORAM CAMERA (Fr., *Chambre Panoram*; Ger., *Panoram Kamera*)

A camera invented by Colonel Stewart, R.E., by means of which a complete circle, or several circles in succession, could be photographed on a band of film. It rotated in one direction on its optical axis, while the film revolved in an opposite direction, the two movements being

so synchronised that a stationary image was obtained.

Also the name given to a daylight-loading Kodak hand camera, with which long, narrow, panoramic pictures are obtainable. The lens swings round on its nodal point during the exposure, so that the image remains motionless and the celluloid film is bent to a curve.

PANORAMIC CAMERA (Fr., *Chambre panoramique*; Ger., *Panorama-kamera*)

Cameras for obtaining panoramic views were made at quite an early date, perhaps the first being that constructed by Marten, of Paris, in 1845, for use with curved daguerreotype plates. Other important panoramic cameras are treated under separate headings. (See "Cyclograph," "Cylindrograph," "Oroheliograph," "Panoram Camera," "Pantoscopic Camera," etc.)

PANORAMIC VIEWS (Fr., *Vues panoramiques*; Ger., *Rundgemälde*)

Panoramic views are best obtained with a camera intended for that class of work, or with a very wide-angle lens, such as the pantoscope. They may also be made by revolving a stand camera on its tripod, and taking a series of photographs, each one continuing the subject at the point where the previous picture left off. Prints from the resulting negatives are trimmed carefully so as to join satisfactorily, and are then mounted to form a continuous picture. Panoramic views have been obtained by taking a series of negatives from slightly separated stand-points, keeping the camera in line, and joining the prints as before. This, however, is much more difficult than the previous method and only of limited utility.

PANTASCOPIIC CAMERA (Fr., *Chambre pantoscopique*; Ger., *Pantaskopische-kamera*)

A panoramic camera, invented in 1862, by J. R. Johnson, arranged to rotate on a circular base by means of clockwork, and which photographed the entire horizon on a flat plate.

PANTOGRAPH

Besides the well-known drawing instrument for proportionally enlarging a photograph or sketch, the term designates an apparatus used by lithographers for enlarging or reducing transfers. A rubber sheet is stretched on a metal frame with mechanical arrangements for stretching the rubber from all four sides, either equally or unsymmetrically. Thus, after a print is transferred to the rubber it can be stretched to enlarge it or unstretched to reduce it, after which the altered image can be transferred to a stone or plate for printing from. Pantograph machines are also used by engravers for enlarging or reducing designs or lettering, and for copying relief objects (such as medals) on to a flat surface. These machines are on the principle of the drawing instrument, but are much more elaborately constructed.

PANTOSCOPE (Fr., *Pantoscope*; Ger., *Pantoskop*)

A lens first made about 1865 by Emil Busch, of Rathenow, and still esteemed for its special purpose. It consists of two symmetrical achro-

matic combinations of deep curves, works at $f/22$, and gives the very wide angle of from 100° to 110° . It is extremely useful for work in confined situations, architectural subjects, panoramic views, etc.

The name pantoscope was also given to a viewing apparatus for photographs, much resembling the alethroscope, lanternoscope, and neomonoscope.

PAPER (Fr. and Ger., *Papier*)

The raw material of paper is linen, cotton-wool, hemp, flax, esparto grass and wood pulp; but for photographic purposes the absence of the last two substances is essential, save in such processes as carbon, where the paper only forms a temporary support for the tissue. The raw material is mechanically torn up, bleached, and then mixed into a pulp with water and the pulp spread on fine-meshed wire, so that the water can drain off and the paper pulp or felt be dried. All paper, except blotting and filter paper, is sized to prevent the undue absorption of water, and very frequently, in addition, filling is used to render the paper more opaque and give it a greater glaze, but at the same time lessening somewhat its strength. The filling may be either silicates, such as kaolin, the carbonates of lime, barium, zinc or lead, or sulphates, such as those of calcium and barium.

Paper contains as a rule about 5 to 10 per cent. of water, and is always more or less hygroscopic, and according to the sizing so it will absorb a greater or less amount of water. Photographic papers are almost always sized in the stuff or mass, but in some cases, especially with the so-called drawing or water-colour papers, the sizing is so poor that it is necessary to remove it by treatment with acid and subsequent washing, and then to re-size with a colloid-like gelatine, agar-agar, etc., in order to keep the photographic image on the surface.

Paper for photographic work must be free from wood pulp, which rapidly yellows on exposure to light, and spoils the emulsion coating or decomposes the free silver salts of printing-out papers. Equally important is the absence of metallic particles—iron, brass, copper, etc.—which might be introduced from the paper-making machine; such particles cause black spots in the case of papers containing free silver nitrate, and generally white insensitive spots in the case of development, though often in the latter case the little white spot will be seen to have a minute black centre, when examined microscopically. The quality of the water used in preparing the paper pulp is also of great importance, as this may introduce foreign matter which acts prejudicially on emulsions. Naturally, too, the absence of "antichlor" is all-important, as in every case this spoils the sensitive film and usually results in spots.

Many photographic papers are primarily coated with an emulsion of barium sulphate (see "Baryta Paper"), which prevents the sensitive film from penetrating the paper, and gives the prints a special surface. The preparation of this coating is as important as that of the paper, and it may also be the cause of peculiar markings and spots, but even this will not allow of a poor quality raw stock being used. One important point in

connection with baryta paper is the homogeneity of the coating, for if the coating is not absolutely even in thickness or hardness, the sensitising material, especially in the case of printing-out papers, will penetrate more or less deeply into the same, and the results are that the prints show a peculiar and characteristic defect known as measles or mealiness.

In process work, the expansion and contraction of paper is of serious importance. For instance, in photo-lithography by paper transfers it affects the scale in such work as map reproduction, and makes the joining up of sections difficult. To overcome this it is usual to allow a definite amount for expansion whilst the paper is damped for transferring, the sheet being measured between two points by means of a trammel rule provided with needle-points. The paper is further damped if it does not reach the required measurement. In colour work the risk which paper undergoes often affects the registering of the colour, and has to be allowed for. As the expansion is greatest in the direction of the web, and is fairly uniform, it is a good plan to mark this direction and use it always the same way, when several pieces have to join or to register.

(For the preparation of the various kinds of papers, see under separate headings. The coating of paper is described under its own heading.)

PAPER NEGATIVES

Fox Talbot, in his calotype process, worked extensively between 1841 and 1856, made his negatives from paper coated with a sensitive silver salt, but this system became almost obsolete when Archer introduced his collodion process on glass. About 1885, however, paper as a medium for negatives again came to the front owing to the increasing popularity of bromide paper, which originally was intended solely for printing by development. In 1884 a specially rapid bromide paper was introduced for negative work, and the Eastman Company and other firms followed with improvements. At the present time celluloid films, roll or flat, have almost superseded paper as a support for the emulsion, but there are still a few photographers who use bromide paper for negative making. Compared with glass, paper is lighter, halation is impossible, it is not brittle, it can easily be stored, it is cheap, and it can be easily cut; but it is not transparent, and, consequently, the time taken in printing is rather long; the grain may be troublesome, and print at the same time as the image, although, if the printing is done on a matt or rough paper, it will be considerably minimised, and possibly caused wholly to disappear. Paper cannot be obtained with so high a rapidity as the fastest plates, and there is a slight difficulty in keeping it flat in the dark-slide and in developing and fixing it.

Generally, bromide paper can be used in exactly the same way as a dry plate, the thinnest, with a semi-matt surface, being the most suitable. Up to half-plate it may be kept flat in the dark-slide without difficulty, but beyond that size some little care is necessary, while it will be advisable to place a sheet of glass or cardboard at the back of the paper, and it may be necessary to coat the extreme edge of the glass or card

backing (or the division plate, if a backing is not used) with a mixture of gelatine and glycerine or similar adhesive. The exposure with an average paper is about three times as long as with an average dry plate; but it depends on the circumstances. Under-exposure must be particularly guarded against. The developers advocated by the paper-makers should be used, and not those specially for plate work; those most suitable are the clean-working developers, such as metol, hydroquinone, amidol, rodinal, etc. Pyro is unsuitable, as it tends to give the shadow (white paper) parts a yellowish tinge, thus prolonging the period of printing. When developing, remember to judge the density by looking through the paper and not upon it. The developed negative is fixed in an acid fixing bath in order to avoid stains, and make the negative as clear as possible. The paper negative is washed, dried, reduced, intensified, toned, etc., in the usual way. Printing is facilitated by waxing the paper to render it more translucent, but most makes of thin smooth bromide paper do not need this treatment.

Four methods are here given for increasing the translucency of paper negatives:—

(1) Rub on warm vaseline with a clean rag to the back of the negative, and apply a warm flat-iron, interposing a sheet of blotting-paper. Should any vaseline get on the film side, remove with benzine. (2) Use white wax and a warm iron as above. Any superfluous wax may be partly removed with turpentine. (3) Apply, as above, a mixture of alcohol 4 oz., and castor oil 1 oz. Ironing is not necessary in this or in the next method. (4) Apply, as above, a mixture of turpentine 5 oz., and Canada balsam 1 oz.

PAPER, VARIETIES OF (See under separate headings.)

PAPIER JOSEPH (Ger., *Seidenpapier*)

A term of French origin and designating a fine tissue paper of a silky character, similar to the best Japanese tissue paper. Used for polishing glass.

PAPIER MÂCHÉ (Ger., *Papiermaché*)

A term of French origin, and designating a material manufactured from paper pulp mixed with size and other substances, and then forced into a mould previously oiled. After drying, the articles are soaked with linseed oil and dried at a high temperature. Largely used for making dishes, trays, and studio accessories.

PAPIER MINÉRAL (See "Mineral Paper.")

PAPIER SEPIA (See "Sepia Paper.")

PAPIER VÉGÉTAL (Ger., *Papier zum Durchzeichnen*)

Tracing paper. A term of French origin, and designating a very transparent tracing transfer paper used in lithography.

PAPIER VELOURS

A pigmented paper used in the Artigue process (which see), and introduced in 1892 by V. Artigue, of Bordeaux. The pigment appears to be held to its paper support by means of gum, gelatine, etc.

PAPYROGRAPHY, OR PAPYROTYPE (Fr. and Ger., *Papyrographie*)

The name given to various methods of transferring impressions on paper, secured by photographic means from line negatives, to stone for photo-lithography. According to Sir W. Abney, any stout paper may be coated with a thin layer of gelatine and hardened in a chrome alum bath. It is then coated with:—

Potassium bichromate .	1 oz.	44 g.
Nelson's flake gelatine .	1½ "	66 "
Water	25 "	1,000 ccs.

When dry, the paper is exposed under a line negative, and drawn through (not soaked in) cold water, being then squeegeed down on a zinc plate. The surplus water is blotted off and the paper inked over with lithographic chalk ink mixed with one-fourth its bulk of palm oil, this being applied with a gelatine roller. The ink takes on the lines which have become insoluble by exposure to light, but is repelled by the moist ground. The inked print is suspended to dry and is exposed to light, in order that the bichromate, which has not been completely washed out of the film, may exert a hardening effect. The print is then transferred to stone by the usual lithographic methods. There have been many variations of this process.

PAPYROTINT (Fr. and Ger., *Papyrotint*)

A process of photo-lithography invented by Husband, in which paper or tinfoil coated with bichromated gelatine and other ingredients is used to obtain a print by exposure to light under a half-tone or line negative. The print is then placed in water for a few minutes, blotted off, and rolled in with a soft lithographic ink, which takes on the lines or image only. Having been dried the print may be transferred to stone or metal for lithographic printing. The method is a modification of the papyrotype process.

PAPYROXYLINE (Fr., *Papyroxyline*; Ger., *Papyroxylin*)

Pyroxyline prepared from paper, usually pure tissue or filter papers, instead of from cotton-wool. It was first introduced by Pelouze in 1838, and used by Crookes, Lyte, Elliott, Sutton, and Liesegang. It presents no particular advantage over pyroxyline prepared from cotton-wool, and has fallen into disuse.

PARA-AMIDO-PHENOL

Para-amidophenol, para-amido phenol, and paramidophenol are other forms of this term.

In the form of a preparation by Lumière, this developer is also known as "Paranol." It is a white crystalline compound, really para-amidophenol hydrochlorate ($C_6H_4OHNH_2$), which is widely used for making up highly concentrated developers in liquid form; for example, rodinal. Amidol resembles, but is not identical with, para-amido-phenol. A concentrated one-solution developer like rodinal may be made as follows:—

Potass. metabisulphite .	3 oz.	33 oz.
Para-amido-phenol .	1 "	110 "
Distilled water (hot) .	10 "	1,000 ccs.

Dissolve in the above order and add slowly a very strong solution of caustic soda or potash until

the precipitate first formed is dissolved. For use, dilute with 10 to 30 parts of water, an average strength being 24 drops to each ounce of water (1 in 20).

Developers may also be made up in an ordinary one- or two-solution form as follows:—

One-solution

Sodium sulphite	. 2 oz.	220 g.
Sodium carbonate	. 1 "	110 "
Para-amido-phenol	. 55 grs.	12 "
Water	. 10 oz.	1,000 ccs.

The above is ready for use.

Two-solution

A. Para-amido-phenol	. 100 grs.	23 g.
Potass. metabisulphite	50 "	11.5 "
Distilled water	. 10 oz.	1,000 ccs.
B. Sodium sulphite	. 300 grs.	69 g.
Potass. carbonate	. 300 "	69 "
Water	. 10 oz.	1,000 ccs.

For use, mix 1 part of A with 2 parts of B. Para-amido-phenol developers are suitable for all makes of papers and they do not stain. Solutions keep good for a long time even in uncorked bottles.

PARA-AMIDO-PHENOL CITRATE

A developer advocated by Dr. Liesegang, who found that citric acid is an excellent solvent for para-amido-phenol, 97 parts (by weight) of which are soluble in 200 parts of a 50 per cent. solution of citric acid in water. The para-amido-phenol should be added gradually at a temperature of from 65° to 68° (18° to 20° C.). The citrate of para-amido-phenol so formed is employed as a developer in the following proportions:—

Para-amido-phenol citrate sol.	. 1 part
Sod. sulphite sol. (concentrated)	5 parts
Sodium carbonate	. 5 "
Caustic potash (10% sol.)	. 2 "
Water	. 50 "

This is ready for use, and may be employed repeatedly. It gives blue-black images with normal exposure, and is said to be suitable for all kinds of plates and papers.

PARABOLIC LENS

A lens whose curves are those of a parabola and not spherical. It has not been found practical to manufacture photographic lenses of this form with the necessary degree of accuracy, although they have been employed in the illuminating systems of microscopes.

PARABOLIC REFLECTOR (Fr., *Réfecteur parabolique*; Ger., *Parabolischer Spiegel*)

A mirror or reflector ground or bent to a parabolic curve, a parabola being the section of a cone cut parallel to its slant side. If an illuminant is placed in the focus of such a mirror or reflector the reflected rays are perfectly parallel, which is only approximately the case with a spherical mirror. Parabolic mirrors are used in photomicrography and for various purposes where parallel rays are necessary, while white reflectors of parabolic or paraboloid curve are employed to secure even illumination of the negative in

enlarging by artificial light when a condenser is not used.

In process work, parabolic reflectors are used on arc lamps, but not so generally since the "enclosed" type of arc lamp has come into use, a semi-parabolic shade reflector being commonly used instead.

PARABOLOID REFLECTOR (See "Parabolic Reflector.")

PARAFFIN (Fr., *Paraffine*; Ger., *Paraffin*)

A solid crystalline mass, translucent, odourless and tasteless, obtained by dry distillation from wood or bituminous minerals, such as petroleum. It is insoluble in water, 3 per cent. soluble in boiling alcohol, soluble in ether and oils, benzole and chloroform. It is used for making paper translucent and waterproofing wooden dishes.

PARAFORMALDEHYDE

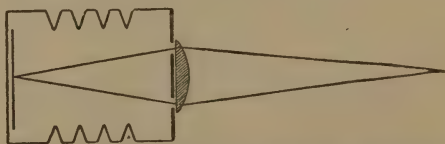
(COH₂)₃. A white crystalline substance, known also as metaformaldehyde and trioxymethylene. Slightly soluble in water, alcohol or ether, soluble in an aqueous solution of sodium sulphite. Advocated in 1903 by Lumière and Seyewetz as an addition to developers. Formosulphite contains paraformaldehyde.

PARAHYDROXYGLYCINE

A synonym for glycine.

PARALLAX STEREOGRAM

An invention of F. E. Ives, of America. The parallax stereogram photograph consists of a single transparent image divided into lines (100 to 150 to the inch), alternate lines forming one of a stereoscopic pair of images, and the intermediate lines forming the other image, so that it has the appearance of a pair of stereoscopic images mechanically superposed. In order that each eye may see only the lines belonging to its respective view-point, the transparency is covered by a line-screen, with a definite separation from the surface of the photograph such that lines of the photograph covered by screen-lines to one eye are seen by parallax of vision by the other eye. The combination of the photograph and line-screen in suitable adjustment constitutes the parallax stereogram, which, when viewed from a suitable distance, directly in front, shows the object in stereoscopic relief. The method of production is by means of a camera having at the front a single plano-convex lens about 3 in. in diameter, behind which are two



A. Camera for Producing Parallax Stereograms

small openings about 2½ in. apart in a horizontal plane (see A); thus an image is formed from two view-points, corresponding to the separation of the eyes. The image thus formed may be a perfectly sharp single image of objects at some

one distance from the camera, in which case objects at every other camera distance will form two images laterally displaced and superposed, exactly as in two ordinary stereoscopic images mechanically superposed. It is then only neces-



B. Inverted Prisms in Front of Lens Apertures

sary to cover the plate with an opaque line-screen suitably adjusted with reference to the spacing of the lines, separation of view-points, and camera extension, in order that the light coming from the two camera apertures may form separate images in juxtaposed lines. A transparency from the negative thus obtained is covered by a line-screen with adjustment like that in the camera, and viewed from a point corresponding to the position of the lens apertures, in order to produce the effect of an ordinary double stereogram in the stereoscope. If, however, these conditions are strictly adhered to, the result will be pseudoscopic instead of stereoscopic, just as in ordinary stereoscopic photography the results are pseudoscopic unless the photographic prints are cut apart and transposed before mounting them for inspection in the stereoscope. The stereoscopic effect is obtained by shifting the cover-screen laterally the width of one screen-line, but with the result that the perspective is distorted when a moderately large angle view is embraced. In order that the path of the rays to or from every point of the stereogram may be absolutely identical in photographing and in viewing, the image formed through each aperture in the camera should be laterally inverted, so that the two pencils of light belonging to near objects bisect before reaching the screen, and pencils from far objects after passing through it. This may be effected by placing laterally inverted prisms in front of the lens apertures, as shown at, B in which *w* represents the path of rays coming from an object more distant from the lens on one side than the screen and sensitive plate on the other. With this arrangement, the objects will be laterally reversed, unless photographed from an intervening mirror, but in other respects the results are much better than without the inverting prisms. The use of the inverting



C. Using Two Separate Lenses



D. Using Two Pinholes

prisms also permits of the large lens being dispensed with. The fact that the prisms may be disposed so as to direct the two pencils of rays towards the axis of the camera in the same manner as the prismatic edges of a single lens,

permits of the use of two separate lenses C, or even of pinhole apertures without lenses D, and this method of controlling the parallax independently of the focal length of the lenses possesses certain practical advantages. Objects can be photographed so as to appear to be at the plane of the photograph, or within or beyond it, at will. When the arrangement shown at C is employed, it is advantageous to have pairs of lenses of various foci, in order to keep to one camera extension, and owing to the small size of the apertures, simple lenses may be used.

The most perfect screen for this work is a 100 line to the inch uncovered Levy single-line screen with "hard filling," and opaque lines twice as broad as the clear spaces. A card-mat separator is used, and the sensitive plate pressed flat by a thick plate-glass at the back in the dark-slide. The requisite thickness of the card separator depends upon the camera extension, which can be readily calculated. The cover screens for the parallax stereograms are made by contact printing on transparency plates from a negative made by contact printing from the original Levy screen, and intensified by mercury and ammonia. The lines should be quite opaque, and the spaces perfectly clear, and, while good enough for this purpose, such screens are not good enough for use in making the negatives. Owing to the fact that neither the transparencies nor the cover-screens are ordinarily flat, it is necessary, in mounting them together, to use a third glass, convex side (preferably ground) against the back of the transparency.

PARA - METHYL - AMIDO - PHENOL - SULPHATE

A synonym for metol.

PARAMIDOPHENOL (See "Para-amidophenol.")

PARAMOL (See "Edinol.")

PARANOL (See "Para-amido-phenol.")

PARAPHENYLENE-DIAMINE

$C_6H_4(NH_2)_2$. One of the hydroquinone series of developers.

PARCHMENT (Fr., *Parchemin*; Ger., *Pergament*)

Paper which has been superficially treated with sulphuric acid, and thus converted into so-called parchment, has been occasionally used for printing, but has not come into general use.

Parchment is used by process workers for covering the tympan of typographic proof presses. It is also used instead of glass, for the autotypist colotype process.

PAROLOGRAPH

An instrument used for obtaining photographic records of the voice.

"PARTS," FORMULÆ IN

The system of stating formulæ in "parts" has some advantages. A "part" may mean anything: a drop to a gallon in liquids, or a grain to a ton in solids; and as long as one keeps to the same unit and multiplies this by the number

in the formula it is impossible to go wrong. The following table will be found useful, as it will save some calculations when quantities are expressed in "parts":

Parts	BRITISH		METRIC	
	Solids Grains	Liquids Minims	Solids (g.) or Liquids (ccs.)	
1	1	1	1	
2	2	2	2	
3	3	3	3	
4	4	4	4	
5	5	5	5	
10	10	10	10	
20	1 scr.	20	20	
50	50	50	50	
60	1 dr.	1 dr.	60	
100	2 scr.	1 " 40 mins.	100	
250	* $\frac{1}{2}$ oz. 32 grs.	$\frac{1}{2}$ oz. 10 "	250	
500	1 " 62 "	1 " 20 "	500	
1,000	2 $\frac{1}{2}$ " 16 "	2 " 40 "	1,000	
2,500	5 $\frac{1}{2}$ " 94 "	5 oz. 1 dr. 40 "	2,500	
5,000	11 $\frac{1}{2}$ " 79 "	10 " 3 " 20 "	5,000	
10,000	1 lb. 6 $\frac{3}{4}$ oz. 49 "	20 " 6 " 40 "	10,000	

* Avoirdupois oz. of 437.5 grs.

This table may be used to some extent for roughly converting amounts in one system to the other. Say, for example, it is required to convert the following or any similar "part" developing formula into one for a solution containing 10 oz. of water:—

Kachin	16 parts
Sodium sulphite	24 "
Sodium carbonate	50 "
Water	1,000 "

The water is to equal 10 oz., then 1 part is equal to 4.8 mins., or 4.5 grs. (precisely, 4.37), for 1 oz. is equal to 480 mins. or 437.5 grs.:

Kachin	$(16 \times 4\frac{1}{2}) = 72$ grs.
Sodium sulphite	$(24 \times 4\frac{1}{2}) = 108$ "
Sodium carbonate	$(50 \times 4\frac{1}{2}) = 225$ "
Water	= 10 oz.

It is near enough in photographic formulæ to take a "part" as meaning 1 gramme or 1 cubic centimetre. Thus, the formula above given will work out as follows:—

Parts	British approx.)	Metric	
		Calculated from British (approx.)	Calculated direct from formula
Kachin 16	72 grs.	16.5 g.	16 g.
Sodium sulphite 24	108 "	25 "	24 "
Sodium carbonate 50	225 "	50.5 "	50 "
Water 1,000	10 oz.	1,000 ccs.	1,000 ccs.

Of course, there is a percentage of error, but this is of small importance in the generality of photographic solutions.

PASSE-PARTOUT

This is a cheap and very effective method of preparing prints for the wall, and is a good substitute for the more orthodox method of framing. The chief drawback is that the absence of the support given by a stout wooden frame results in fragility; so that while passe-partouts are quite satisfactory for home use, they run serious risks if sent to exhibitions. Briefly, the method consists in binding together by the edges a sheet of glass, a mounted print, and a backboard, and providing a means for hanging up. The actual work is carried out with many variations, but the outline of one course of procedure will be sufficient to indicate the general lines to be followed.

The mount of the print should be sufficiently stout to ensure its lying flat, as with a thin paper mount it is difficult to secure such close pressure against the glass as to prevent buckling. A sheet of glass the size of the finished picture is cut, taking care that the edges are as clean-cut as possible, and the shape truly rectangular. This glass is used as a template for trimming the print and for marking out a rectangle on a piece of very stout strawboard. If this latter is of the right kind and thickness it will have less "give" in it than a similar piece of wood. It is extremely hard to cut with a knife, and those who have a fine-cut saw, or even a fret-saw, available will find it an advantage. Glass, mount, and backboard should now be of the same size, with the edges flush and even all round.

Before binding up, the backboard is fitted with a hanging arrangement. Tapes are sometimes glued on for this purpose, but a better method is to use paper fasteners and curtain rings. The former should be of large size, say about $1\frac{1}{2}$ in. or $1\frac{3}{4}$ in. long; the latter are hollow brass rings about $\frac{3}{8}$ in. in diameter. The backboard is pierced with two holes, a ring is slipped between the forks of the fastener and drawn tight up to the head, and the fastener is then pushed through the hole, opened out, and hammered down flat. If the rings are so held as to occupy the best position for taking the pull of the cord, it will be found that the flattened paper fasteners incline towards each other, and are not parallel to the sides of the backboard. They will resist a pull very much greater than will be put upon them by the weight of the finished picture.

Excellent binding for the edges can be bought in rolls, and of different colours. Grey, black, and brown are the most useful. The strips are of tough "pebbled" paper, already gummed with a strong adhesive. The glass having been thoroughly cleaned the three component parts are put evenly together, and laid, glass side up, so that one side projects very slightly over the edge of a table. A piece of edging the length of this side is cut from the roll, drawn under a straight-edge or through the fingers to remove the curl, and the gummed side moistened with a brush, being careful not to take off the adhesive. With a little practice this strip can be laid evenly along the edge of the glass, using the thumbs at each end to adjust it, and keeping about one-third of the width on the glass. The strip is then thoroughly rubbed down into close contact with a duster. The whole thing is now turned carefully over, and the free edge of the strip

drawn tightly over and rubbed down on to the backboard. The opposite edge is done in the same way, and then the other two edges, allowing time between each for the last strip of edging to set. Some prefer to mitre the corners of the strips, but if one is placed over another the difference cannot be detected at a little distance. Should alternations of wet and dry weather subsequently cause the edging to leave the glass in places it can be re-damped and rubbed down again. In extreme cases it is a simple matter to renew the binding altogether.

PASTE (See "Encaustic Paste" and "Mountants.")

PASTELS

Prints, upon paper or opal, coloured with crayons; the pastel proper, however, has no photographic basis. Pastel colours are opaque, and the print selected for colouring should be light and of a cold tone. Details are hatched or stippled with the point of the crayon, but broad tints are rubbed in with the finger or stump. Such pictures when coloured are liable to injury because of the colours being in a kind of powder on the surface. If not mounted up at once in a frame and behind glass the work should be sprayed with a weak solution of rice water, or with the following:—A. Mastic, 24 grs.; amyl acetate, 3 oz. B. Celluloid (old photographic films washed free from emulsion), 7 grs.; amyl acetate, 3 oz. Dissolve, and when, after some hours, both solutions are clear, mix together and keep in a tightly corked bottle. Another method is to strain over the crayon work a piece of thin nainsook, and then rapidly and lightly to brush over a weak solution of isinglass.

PATENTS

The governments of the civilised countries grant inventors the sole right to their inventions for a term of years, in consideration of a full disclosure of the invention, the payment of certain fees, and conformity to certain regulations. Application for a British patent may be made in two ways. (1) By lodging what is known as a provisional specification, to be followed within six months by a complete specification. (2) By lodging a complete specification in the first instance. In most cases it is best to adopt the first course, as the period ensuing between a provisional and complete application affords the inventor an opportunity of developing his ideas and ascertaining by practical tests the best ways and means of carrying his invention into effect. The provisional specification, however, must clearly foreshadow the object of the invention and indicate to some considerable extent the methods to be adopted in carrying the invention to a practical issue; hence, as the provisional forms the basis for the complete patent, it should be prepared with the utmost care, especially as nothing which has not been intimated in the provisional may be included in the complete specification. If the inventor discovers improvements after filing his provisional, he cannot include them in his complete specification, but he may (in virtue of the Patent Act of 1907) apply for a patent of addition, in respect of any

modifications or improvements upon the invention as originally patented, and no renewal fees beyond those in respect of the original patent will be involved. Official patent forms are supplied free of charge. For a provisional application, one copy of Patent Form No. 1 and two copies of Patent Form No. 2 are required. Before it is lodged at the Patent Office, No. 1 will require the Government stamp (cost £1) to be impressed thereon. No stamp is required on the two copies of Form No. 2; and No. 1 may be obtained already stamped before filling in the form, if desired.

The provisional specification is commenced on Form No. 1, and continued on wide-ruled foolscap paper, leaving a margin of 1 in. on the left-hand side. It may be delivered by hand or sent by post, on receipt of which it will be officially dated and numbered.

A provisional specification is not published, but remains secret during the period of provisional protection, and until the acceptance of the complete specification. As soon as a provisional application has been filed the inventor may safely show his invention to any interested party, but he should be quite certain that he has properly described his invention and satisfactorily covered his idea. Provisional protection lasts for six months, or seven months by payment of a fine, and at any time before the expiry of the period of provisional protection the inventor must file his complete specification, otherwise the application is considered to be abandoned.

Complete specifications, with their all-important claims, should not be filed without expert assistance. It is a good plan for the inventor himself to make a preliminary search for novelty, before involving himself in the necessary expenses of completing the patent through a qualified agent. The Patent Office in Chancery Lane, London, offers every facility to visitors to make their own searches, but it is a long task to anyone unacquainted with the system, and in any case involves time and patience. For this reason the services of special search agents are useful. Persons who cannot go to the Patent Office in person, and yet have time at their disposal for the search, may obtain copies of all specifications filed, in either the original or an abridged form. For example, suppose an inventor of some photographic appliance wishes to ascertain how much novelty exists in his invention; he may purchase ten volumes at 1s. each, post free, in which he will find tabulated and conveniently indexed all patents in photography from the year 1617 almost to date. The abridgments relating to photography come under Class No. 98. From the index he may find all inventions which have any serious bearing on his particular apparatus. After selecting any which may be thought to encroach upon his ideas, he may further obtain the full specifications for 8d. each. Having satisfied himself with respect to these he may bring his search up to date by engaging an agent, to furnish information of any other specifications a view of which can only be got by visiting the Patent Office itself. Such a procedure often saves an inventor the expense of lodging a complete specification and then

in the end discovering that he has been completely anticipated. The Comptroller of Patents causes a search to be made through British specifications for fifty years back from the date of every application for a patent. Only complete specifications, either after provisional, or complete in the first instance, are subject to the search, and the Comptroller has the power to insist on the amendment of the specification or on the insertion of a reference to existing patents, and so to place it in interference therewith. A preliminary and independent search by the inventor before filing a complete specification often reveals prior applications with which he may be able to avoid clashing by means of judicious wording in his complete specification, thus obviating the addition of troublesome references to prior patents—references which are likely to discount the value of his patent.

A sealed Royal Letters Patent alone enables an inventor to obtain absolute protection for fourteen years, and allows of legal action being taken against infringers, annual renewal fees being payable from the end of the fourth year.

The complete specification must be begun upon Patent Form No. 3 (stamp, £3), and continued on foolscap paper. An unstamped duplicate copy is also required. The specification should contain a full and detailed description of the invention, of such a nature that the invention could be carried into practical effect by a competent workman. Drawings are also required where a mere description would fail to make everything absolutely clear. Instructions to applicants for patents (supplied free) give clear directions not only for drawings but also for the mode of applications, provisional and complete. The complete specification, together with its claims, is a most important document. The drafting of claims is a task that should be done by a fully qualified and registered patent agent, because when a specification comes to be construed in a court of law, the wording of the claims is subjected to a searching scrutiny, and if there is any flaw the patentee will generally fail to support his monopoly. Further than this, the claims should always be drafted in the first instance as wide as is reasonably possible, because there will then be an opportunity of reconsidering them in the light of the fuller knowledge of prior patents disclosed by the Patent Office search.

The total amount of Government stamp duty for a British patent is £1 on provisional application, £3 on completing same; or £4 on complete application in the first instance. A further fee of £1 is payable in order to obtain the issue of a patent on an accepted application. Before the end of the fourth year, dating from the first application, £5 becomes due in respect of the fifth year; before the end of the fifth year £6 in respect to the sixth year, and so on, increasing £1 each year during the period (fourteen years) the patent may be kept in force. The period is extended only in very special circumstances.

PAUL'S ANIMATOGRAPH

One of the earliest commercial cinematograph machines, patented by R. W. Paul, and at first called the "Theatrograph."

PAYNETYPE

A photo-mechanical process invented by Arthur Payne. Zinc plates are coated with a gelatino-bromide emulsion and exposed direct in the camera. In order to obtain the necessary reversal of the negative image the plate is coated, before the application of the emulsion, with a resinous varnish. After exposure and development with an alkaline developer, the image is treated with a 5 per cent. solution of potassium bichromate, which hardens the image so that it can be developed with hot water, like a carbon print. Thus the soluble gelatine forming the half-tone dots or lines of the negative image is washed away, leaving the varnish ground clear in those parts. The plate is then dried and immersed in methylated spirit, which dissolves the varnish in the places uncovered by the gelatine, the zinc thus being left bare. A coating of ink is next applied and attaches itself to the bare zinc, whilst it can be developed away in the parts which are still covered with varnish and gelatine. The plate is then ready for the etching process.

PEARL-ASH

Impure potassium carbonate.

PELLETONES

An early name for chemicals sold in a compressed form. Pyrogallie acid was the first to be sold in this way. The term has also been applied, but very rarely, to the results of the Pellet iron-printing process.

PELLET PROCESS

An iron (blue-print) process—the true cyanotype, which gives blue lines on a white ground when a copy is made from a line tracing. It is a "positive from positive" process, and unsuitable for use with ordinary negatives because negative prints would then be obtained. The process is also known by various other names, such as "Cyanofor," "Positive Ferrottype" and "Cyanographic," and is largely used for the reproduction of technical drawings. Pellet's own formula has always been kept a trade secret, but Dr. Liesegang gives the following, which answers quite well:—

Common salt	.	.	144 grs.	33 g.
Tartaric acid.	.	.	156 "	36 "
Ferric chloride	.	.	384 "	88 "
Gum arabic	.	.	2.5 oz.	275 "
Water	.	.	10 "	1,000 ccs.

Dissolve the gum in one half of the water, the other ingredients in the remaining half; mix, apply to paper in the manner described under the heading "Blue-print Process," and dry quickly. An exposure, under the tracing, of one or two minutes is sufficient in bright sunlight. The print is developed by floating it face downwards on a saturated solution of potassium ferricyanide (none must reach the back of the print); then wash for a minute or two in water and immerse for about ten minutes in a clearing solution of water 100 oz., hydrochloric acid 8 oz., sulphuric acid 3 oz., finally thoroughly washing and drying.

A modern formula, due to Pizzighelli, is given on the next page.

A. Pure gum arabic .	264 grs.	60.5 g.
Water	3 oz.	300 ccs.
B. Ferric ammonio-citrate	220 grs.	50 g.
Water	1 oz.	100 ccs.
C. Ferric chloride (crystals)	220 grs.	50 g.
Water	1 oz.	100 ccs.

The gum solution does not keep well, but the others do, if stored in the dark. For sensitising paper take of—

Solution A (gum)	2½ oz.	250 ccs.
„ B (citrate)	1 „	100 „
„ C (chloride)	5 drms.	1 „

Add B to the gum, shake well, add C, and shake again. If mixed in any other way the gum may coagulate. The paper is coated and dried like blue-print paper and exposed under a tracing. Exposure is very brief (a minute to a minute and a half in strong sunlight), the image showing faintly. The print is developed in a solution of 1 oz. of potassium ferrocyanide (yellow prussiate of potash) in 10 oz. of water. The lines should develop to a brilliant blue, without any blueness in the ground, which would indicate under-exposure; broken and feeble lines are due to over-exposure. The print is washed for a few seconds in order to remove most of the developer, and then fixed in an acid bath, sometimes called a bleaching bath, made by mixing ½ oz. of strong sulphuric or 2 oz. of hydrochloric acid with 20 oz. of water. The prints, face upwards, remain in this bath for five or six minutes, and are then thoroughly washed. A light blue deposit is often seen upon the white parts of the paper, but this washes off, or it may be removed with a very soft brush or cotton-wool. Any blue stains (or, in fact, the whole of the image) may be removed with a solution of about 70 grs. of potassium oxalate in 1 oz. of water (4 g. in 250 ccs.), washing well afterwards. (For selection of suitable papers, method of sensitising, etc., see "Blue-print Process.")

PELLICLE PROCESSES

Early dry-plate processes in which the prepared emulsion was supplied for the purpose of melting up and coating plates at home. Kennett patented a pellicle (a compound consisting of gelatine, silver nitrate, bromide, etc.) in November, 1873.

PENCIL, BROMIDE

A specially prepared pencil for spotting and working-up bromide prints, for particulars of which see "Bromide Pencils."

PENCIL, RETOUCHING (See "Retouching.")

PENTANE (Fr. and Ger., *Pentane*)

Synonym, amyl hydride. C_5H_{12} . Molecular weight, 72. A colourless, mobile liquid, obtained from coal tar or petroleum. Boiling point, 98° to 100° F. (36.6° to 37.7° C.). Its vapour is extremely inflammable. It is used in the pentane lamp.

PENTANE LAMP

A special form of lamp adopted by the Board of Trade as a standard light. Ordinary coal gas

is passed over the surface of pentane, of which it absorbs some, and thence to an Argand burner. If precautions are taken as to the pressure and height of flame, it gives a very constant light source, which, however, is open to the objection that its spectrum is very poor in violet and ultra-violet, and therefore not comparable to daylight for photographic purposes. It is frequently known as the Dibdin-Harcourt pentane lamp, and may be obtained of either ten or one candle-power. It is used as a primary light standard for photo-chemical work.

PENTATHIONIC ACID (Fr., *Acide pentathionique*; Ger., *Pentathionsäure*)

$H_2S_5O_6$. Molecular weight, 258. One of the higher sulphur acids, of very little practical interest. Lumière and Seyewetz suggested the use of lead pentathionate dissolved in "hypo" as a toning agent instead of gold; but it has found no practical use, as the final image consists of lead, silver, and sulphur, and is somewhat liable to change.

PEPPERTYPE

A process of making ceramic enamels.

"PER CENT" SOLUTIONS (See "Solutions, Making up.")

PERCHROMIC ACID

A term sometimes used as a synonym for chromic acid (chromic anhydride), though the formula for perchromic acid is written $Cr_2O_7 \cdot H_2O$ and that of chromic acid is CrO_3 .

PERIOD

A term proposed by Scheffer to denote the size of the units of screens and screen-plates. The period for lines equal in width to the interspaces is twice their separating distance. Thus, in the diagram, which represents a black-and-white screen of equal spacing, the period is shown at



Diagram of Black-and-white Screen of Equal Spacing

the top by P; the elements of the screen are indicated at S. Any screen of which the period is $\frac{1}{1500}$ of the distance from the eye can be resolved into separate lines. From this it is obvious that, assuming 8 in. or 20 cm. as the distance of normal vision, the screen period will be $\frac{1}{1500}$ in. or $\frac{1}{1500}$ mm. Therefore the separate units of the screen will be invisible if they are not larger than $\frac{1}{1500}$ in. or $\frac{1}{1500}$ mm.

PERISCOPE, OR PERISCOPIC LENS

Usually an uncorrected rectilinear lens. The earliest model was made by Steinheil, in 1865, and consisted of two very thin meniscus lenses mounted closely together. It embraced a very wide angle (nearly 100°), and had an initial intensity of $f/40$. The modern periscopes are

usually more rapid in action, say $f/9$ to $f/11$, but their visual and chemical foci do not coincide.

PERMANENCY

The stability of a photographic image is determined primarily by the process by which it was produced, but it is limited by the durability of the medium on which the image is supported. If the image will endure without serious loss of quality as long as the medium will last, it may be regarded as permanent. In some cases the image is almost indestructible, and therefore has much greater durability than its support. Deterioration is far more frequently the result of defective or careless working than an inherent weakness of the process. Gelatine, thoroughly hardened, is an enduring substance. Paper of good quality and purity will last for hundreds of years without other change than a mellowing of its colour. In silver processes, imperfect fixing is a frequent cause of fading in negatives and prints, even the washing being of secondary importance. A properly fixed and washed negative should be permanent, especially if varnished to protect it from the atmosphere. Properly made carbon and platinotype prints are quite permanent; imperfect adhesion of the carbon tissue to its final support, or incomplete removal of the iron salts from platinotype, will cause rapid deterioration, although metallic platinum is absolutely permanent. A sulphide-toned bromide print should be as enduring as any photographic print, silver sulphide being a most stable substance. An ordinary bromide print should be as enduring as a negative, but all prints on gelatine papers should have the gelatine coating hardened; in its soft condition it will absorb moisture from the air, and this is prejudicial to its stability. Silver prints on the various printing-out papers are generally considered to be far from permanent; but the trouble is invariably due to imperfect work, and is not inherent in the process. Silver prints have been kept for nearly twenty years without showing any change beyond the mellowing of the paper.

PERMANENT SUPPORT

The paper used for the second transfer in the double-transfer method of the carbon process.

PERMANGANATE INTENSIFIER

A process of intensification by means of potassium permanganate, described by T. Thorne Baker before the Royal Photographic Society in 1905. In the result, the contrasts are slightly reduced. The negative is washed and placed in the bath given below for between one and three minutes, during which time the image is transformed into a reddish-pink, and apparently loses very much in density:—

Potass. permanganate.	96 grs.	22 g.
Hydrochloric acid (concentrated)	. 50 mins.	10 ccs.
Water	. 10 oz.	1,000 "

It is rinsed in water and developed, preferably by hydroquinone with caustic soda. The red plate, when immersed in the developer, quickly becomes brown, and finally black, the whites again becoming perfectly clear. Finally, the negative is washed.

PERMANGANATE REDUCER (See "Reducing Negatives by Chemical Means.")

PERSAL

An etching mordant for copper, based on ferric perchloride, and obtainable in either solid or liquid form.

PERSISTENCE OF VISION

The impression made by light upon the retina of the eye does not instantly disappear when the light is removed, but remains for an appreciable length of time which largely depends upon the length of the period during which the eye has been exposed to the light and also upon the intensity and colour of the light. A sentence, which is probably the first written, having reference to persistence of vision, is contained in the fourth book of "De Rerum Natura," by Lucretius, written about 65 B.C. He there says: "This [perception of movement] is to be explained in the following way: that when the first image passes off, and a second is afterwards produced in another position, the former then seems to have changed its gesture. This we must conceive to be done by a very rapid process," etc. There are many simple and familiar illustrations of the phenomenon of persistence of vision. Thus, a flash of lightning appears much longer than it really is, and a burning stick whirled rapidly round appears to be a circle of fire. If the seven prismatic colours be properly arranged in their due proportions in a circle, and this turned rapidly on a central axis, a white surface is the result. This law of the persistence of vision constitutes the fundamental basis upon which the cinematograph exhibition rests, and the motion picture is the finest demonstration of the facts it is possible to conceive, though not, perhaps, so self-evident as it becomes in the simpler appliances, such as the so-called "Wheel of Life," or the phenakistoscope.

PERSPECTIVE (Fr., *Perspective*; Ger., *Perspektive*)

Assuming that lenses are free from distortion, that they are opposite the centre of the plate, and that the plate is vertical, all lenses will give the same drawing or perspective from the same standpoint. If the focal lengths vary, more or less of the subject will be included, but such objects as are rendered by all will be identical in perspective.

A good deal of misapprehension has arisen from the fact that, more often than not, lenses include far more than can be seen clearly by the eye from the same standpoint. If a lens of very short focus is used on a large plate, the resulting picture is sometimes said to have incorrect perspective. It is only incorrect in the sense that the eye, placed in the same position as the lens, is not adapted for seeing the same amount of the subject. If the eye could include as much as the lens, it would see precisely what the lens renders. As, however, photographs are made to be looked at, it is desirable to avoid this "unnatural" perspective. This can be done by using lenses of such focal length that the pictures they draw approximate to those seen by the eye. When a lens has included so much

that the effect to the eye appears strained and unnatural, the exaggeration may be removed by trimming away more or less of the outer parts. Another cause of abnormal drawing is the taking of what was originally a subject at one side of a picture and presenting it apart, as though the lens had originally been directed straight at it.

The point of view has a great deal to do with the perspective or "drawing" of an object. In every case the perspective will be accurate for that particular viewpoint, but the resulting arrangement will not necessarily be pleasing simply because it is correct. So that, inasmuch as the photographer does not have to concern himself at all with the correctness of the "drawing," he must direct his efforts to the consideration of such a point of view, and the use of such a lens, that the result shall appear natural and pleasing to the eye.

The unnatural appearance of a wide-angle picture is accentuated if the whole of the subject is enlarged. This is because a large print is generally viewed at a greater distance than a small one, whereas the shorter the focal length of the lens employed the closer to the print should the eye be placed for the perspective to appear natural. The unnatural appearance is also emphasised when some of the objects included were comparatively close to the lens. For example, an upright picture on a near wall may apparently be elongated into a horizontal one, and only assumes its natural proportions if it can be viewed at a distance something like that of the focal length of the lens used. (*See also "Perspective, False."*)

PERSPECTIVE, AERIAL (*See "Aerial Perspective."*)

PERSPECTIVE, FALSE

That the photographic lens cannot render a scene in false perspective has been stated under the heading "Perspective," but it is there pointed out that photographic images are not always pleasing to the eye. The terms "false perspective" and "distortion" are often applied to views which show "violent" or "sudden" perspective, due to the use of a wide-angle lens. Perhaps the nearest approach to false perspective which can be obtained in photography is by the use of the swing back, which is often brought into operation in order to secure depth of definition when using a comparatively large aperture. An example of this may be found in an ordinary street view, in which one side of the road is much nearer to the camera than the other, and consequently is out of focus when the centre is sharp. To remedy this, one side of the swing back is pulled out, thus bringing the near portion into focus, but of course on a larger scale than it would have been if the plate had been kept at right angles to the axis of the lens. Something similar occurs when the vertical swing is used to obtain covering power in portraiture, general sharpness being obtained by tilting the back to bring the hands and knees into focus at the cost of truthfulness.

PETROLEUM SPIRIT

A synonym for benzine.

PETZVAL, J.

A Viennese mathematician who, in 1841, devised the first "rapid" portrait lens. It was of short focal length, worked at what was then a large aperture, and was manufactured by F. Voigtländer, of Vienna. It consists of a front combination formed by a biconvex lens of crown glass cemented to a plano-concave lens of flint glass. The back combination is composed of two separated lenses, a concavo-convex of flint glass and a biconvex of crown glass. (For illustration, *see "Lens."*) It enabled exposures to be reduced to one-tenth that previously necessary. In 1858, Petzval worked out the "orthoscopic" lens for landscape work, but this lens was little superior to the single landscape lens, although the subject of great claims. (*See also "Lens."*)

PHANEROGENE

A developer introduced in 1894 by Reverdin and De la Harpe, and having a character resembling that of amidol; now of but small importance.

PHANTASMOGRAPH (Fr., *Phantasmographe*; Ger., *Phantasmograph*)

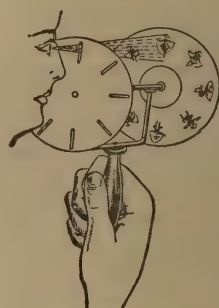
An early apparatus used for printing lantern slides, consisting of a long box or tube having a hinged door at one end to admit light, the negative, with the lantern plate in contact, being placed at the opposite end. Apparently, the object was to exclude all possible extraneous light.

PHANTOM DEVELOPMENT

A fanciful term applied to a method of development with a solution strong in the developing agent but weak in alkali, so that a faint image is first obtained, and then continuing with a solution strong in reducer, alkali, and restrainer.

PHENAKISTOSCOPE

Synonym, stroboscope. An instrument invented simultaneously, by, Plateau, of Ghent, and Stampfer, of Vienna, in the year 1832. It has been made in various forms, an example of which is illustrated. Two discs are mounted on a common spindle; they rotate in the same



Phenakistoscope

direction and at an equal speed. One disc is perforated with slots, through which an observer may view a series of pictures depicted on the inner surface of the companion disc. The series of pictures consists of successive phases of



BY P. R. SALMON, F.R.P.S.

INFLUENCE OF THE LENS ON PERSPECTIVE

The upper view, taken with a narrow-angle lens, conveys but little idea of distance between the footbridge and the farm. In the lower view, however, taken with a wide-angle lens and from a much nearer standpoint, the distance appears to be greater. The bridge is of approximately the same scale in both views.

any object in motion; as for example, a girl skipping. The number of phases corresponds to the number of slots in the viewing disc. On making the discs rotate rapidly, the observer gains a momentary view of each picture in the series as each slot arrives opposite its respective image. In virtue of the law of persistence of vision, therefore, a blending of all the pictures in the series takes place on the retina of the eye, giving the impression of a single figure invested with life or motion. In a modified form of the instrument, the disc bearing the pictures, as shown in the figure, is dispensed with, by depicting the pictures on one side of the slotted disc and viewing them through the slots by reflection in a mirror; this, indeed, was the earliest form of the apparatus. Phenakistoscope is the name given to the instrument by Plateau, while Stampfer calls it by the name of stroboscope. As an early instance of confusion of terms it may be mentioned that Snell, writing in 1835, calls the stroboscope by the name of "Phantascope" or "Kaleidorama." Müller, in 1846, applied this instrument for the demonstration of wave-motion, and Poppe, Savart, and others employed it for the synthesis of other natural motions. The first attempts at projecting animated effects upon the lantern screen were founded on the type of machine here illustrated, the disc bearing the series of pictures being on transparent material, and light thrown first through it, then through slots, and finally on to the screen by means of an objective. This was done by Uchatius between 1851 and 1853, but Plateau himself had practically attacked the same problem in 1849 in a modification of his anorthoscope, in which apparatus he produced four non-distorted images from a distorted original by the introduction of compensating lenses. Plateau placed sixteen images in progressive series round the margin of a glass disc, and in front of this, in a reversed direction, revolved, at a four times greater speed, an opaque disc with four slots. The front of the apparatus could be observed by many people at once, and to prevent confusion the parts of the disc showing the non-erect images were screened off. It will be seen that as a slot passed the aperture in the screen one image would be viewed and the light then cut off while the transparent disc turned one-sixteenth of its diameter and the opaque one one-quarter. The next image would then be revealed, by its coincidence with the slot, in the same position as that in which the previous image was observed. (See also "Zoëtrope.")

PHENIC ACID, PHENOL, PHENYLIC ALCOHOL, AND PHENYL HYDRATE

Synonyms for carbolic acid.

PHENYLAMINE

A synonym for aniline.

PHLOXINE

A variety of eosine.

PHOSPHATE PLATES AND PAPERS

Plates or papers coated with an emulsion in which silver phosphate is practically the light-sensitive salt. The light-sensitiveness of this

substance was discovered by Stromeyer about 1830, but Fyfe, about nine years later, was the first to use it for printing out, and he salted his paper with sodium phosphate, sensitised on silver nitrate and again floated on sodium phosphate. He also used an ammoniacal solution of silver phosphate, and recommended merely washing with water or ammonia for fixing.

Many years later, Lyte used this salt for albumenised paper and employed nitric acid for fixing; later (published, 1856) he used a mixture of sodium phosphate and tartrate, Rochelle salts in sugar of milk and gelatine, and stated that there was no precipitate formed, thus antedating the later use by Meyer of silver phosphate dissolved in an organic acid. It was also tried by Hunt and Hardwich. Meyer (*Brit. Journ. Phot.*, 1899 and 1900) precipitated his phosphate and dissolved it by the addition of an organic acid, such as citric, tartaric, acetic, etc., and used it with and without a vehicle on paper. Silver phosphate alone or with excess of silver nitrate, however, gives an exceedingly long range of gradation, so that unless extremely vigorous negatives are used the prints are very flat, wanting in intensity, and without any whites. Valenta, in 1900, took up the study of the subject, and suggested a collodion emulsion by adding silver nitrate to phosphoric acid collodion, but this also possessed the same fault, though to a less degree. Further experiments were made to increase the intensity and reduce the gradation by mixing it with varying proportions of collodio-chloride emulsion, or by the addition of uranyl and cupric chlorides; and finally, in 1905, he gave a satisfactory working formula, which can not only be printed out, but also physically developed:—

Raw collodion (3-3½%)	20 oz.	1,500 ccs.
Phosphoric acid (20%)	128 mins.	20 "

Mix, and add—

Citric acid	. . . 384 grs.	60 g.
Alcohol	. . . 640 mins.	100 ccs.

Then add—

Silver nitrate (powdered)	. . . 384-512 grs.	60-80 g.
Liquor ammoniæ (.880)	q.s.	q.s.

Enough ammonia should be used to form a perfectly clear solution, and then—

Absolute alcohol	. . . 3½ oz.	250 ccs.
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added, the mixture being added in small quantities at a time to the acid collodion, shaking all the time. Then add—

Ether	. . . 3½ oz.	250 ccs.
Glycerine alcohol (1:1)	128 mins.	20 "

This may be coated in the usual way on matt or glossy baryta paper. It may be fully printed out or only until the outlines of the image are just seen, and should then be developed with the following:—

Metol	. . . 155 grs.	35.5 g.
Glacial acetic acid	. . . 10 oz.	1,000 ccs.
Distilled water	. . . 10 "	1,000 "

For use, 40 drops of this should be diluted with

$3\frac{1}{2}$ oz. or 100 ccs. of water. The colour of the prints thus obtained varies from sepia to brownish black or purple.

Recently, several makers have placed phosphate papers on the market which may be treated as outlined above.

PHOSPHATES (Fr., *Phosphates*; Ger., *Phosphats*)

Salts prepared by the combination of a metal with phosphoric acid. There are generally three forms: the mono- or acid phosphate, such as sodium orthophosphate, $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$; the di-orthophosphate, $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$; and the tri-orthophosphate, $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$; these are obviously formed by the replacement of one, two, or three hydrogen atoms respectively of orthophosphoric acid H_3PO_4 .

PHOSPHORESCENCE

The researches of T. A. Vaughton and others seem to have demonstrated that the sensitive silver salts, such as the bromide, iodide and chloride, if precipitated and kept in the dark, have the property, under certain conditions, of emitting light in degrees proportionate to their sensitiveness. In a red light, an unexposed bromide plate is placed in an ordinary pyro-soda developing solution for ten minutes, removed and washed. Next, in total darkness, plunge it suddenly into a dish containing a saturated solution of aluminium sulphate, and the plate and the solution will immediately become phosphorescent, the light dying away in the course of a minute or two. On pouring the solution into a bottle, the whole body of the liquid becomes luminous and remains so for several minutes, the light being increased by shaking. If half the plate is exposed to the action of white light for a second before treating with the pyro-soda solution, that half remains dark and emits no light when the plate is put into the aluminium sulphate. If the plate is given a short exposure in the camera, and developed and put into the aluminium sulphate solution, the image will appear dark on a phosphorescent background. Precipitated silver bromide (which has been kept a few days in a corked test-tube in the dark), contained in a porcelain dish and exposed to a bright-red light while adding the pyro-soda solution, appears black, but on pouring off the solution the precipitate gradually assumes a bright green appearance under the red light, while in white light it appears dark grey or black.

As the result of a series of supplementary experiments, H. Edwards has stated that not only the plate itself, but also the used developer, will give phosphorescence with alum solution. Quinine sulphate or hydrochloride is not luminous when the used developer is added, but becomes so if a few drops of sulphuric acid are subsequently introduced. The experiment may be still more easily made by mixing potassium bromide and silver nitrate solutions in dim gaslight, decanting, and shaking up the resulting silver bromide with pyro-soda. A red liquid results which gives a luminous effect when poured into alum solution or dilute sulphuric acid.

Dr. J. Precht explains the phenomenon of phosphorescence as follows: (1) The alkaline

pyrogallol acid solution liberates oxygen on the addition of acids, by which the sodium sulphite is oxidised to sulphate, this oxidation being accompanied by phosphorescence. (2) The acid pyro solution suddenly takes up oxygen on the addition of sodium sulphite and soda, and also this oxidation is accompanied by phosphorescence. Thus easily reducible substances produce phosphorescence with an alkaline pyro solution.

Potassium permanganate, for instance, is phosphorescent when a mixture of pyrogallol acid and soda is added to it. It is assumed that an intermediary product is formed of alkaline pyro solution and oxygen, which gives off again the oxygen only on the addition of acid, and that the then liberated oxygen gives rise to phosphorescence by combining itself with the sulphite to form sulphate. Phosphorescence is liable to fog gelatine plates should these retain traces of the pyro developer, and therefore, in practice, such plates should not pass from the pyro developer into a solution of alum or of citric acid, or, indeed, to any other solution, before the last traces of the developer have been removed from it by careful washing. Exceedingly small quantities of pyro, less than .005 per cent., are sufficient in some cases to cause a bright phosphorescence of the film.

PHOSPHORESCENT PHOTOGRAPHS (See "Luminous Photographs.")

PHOSPHORIC ACID (Fr., *Acide phosphorique*; Ger., *Phosphorsäure*)

Synonym, orthophosphoric acid. H_3PO_4 . Molecular weight, 98. Solubilities, miscible in all proportions with water and alcohol. Obtained from phosphorus by oxidation. It occurs in a crystalline state, and is then nothing else but phosphoric acid; but usually the so-called "syrupy" acid is met with, and this contains 85 per cent. of phosphoric acid, and has the specific gravity of 1.725. Another acid, of specific gravity 1.347, contains 50 per cent.; and the dilute, of specific gravity 1.057, contains 10 per cent. A 20 per cent. solution, having a specific gravity of 1.12, is the one usually employed for acidulating the platinum toning baths.

In process work, phosphoric acid is used in photo-zincography as an addition to the gum and nutgalls solution used for damping the plate before rolling-up with ink, its object being to preserve the cleanliness of the white parts of the plate. Also it is used in preparing aluminium for lithographic printing.

PHOTO SALTS

A name given first by Carey Lea to the coloured reduction product formed by the action of light on silver chloride, and later applied generally to the coloured salts obtained chemically by Lea, who considered the coloured reduction product to be a chemical combination of silver chloride AgCl and silver subchloride Ag_2Cl . Hodgkinson, on the other hand, ascribed to it the formula $\text{Ag}_3\text{Cl}_2 \cdot \text{Ag}_2\text{O}$, as he considered that the ever-present aqueous vapour or water played an important part in its formation. According to the latest theories, this product is a solid solution of Ag_2Cl in AgCl . Lea prepared the dark-

coloured products by the action of an alkaline hypochlorite or ferric chloride on finely divided metallic silver, by partial decomposition of silver oxide by heat and treatment with hydrochloric acid, by reducing silver chloride dissolved in ammonia by ferrous sulphate, or by the action of cuprous chloride on silver nitrate, etc. The colour of these photochlorides varied from purple to golden or rose red, and they were then capable of assuming the colours of the spectrum or any coloured objects to which they were exposed. These salts are of great interest, as no doubt they play an important part in the formation of the colours in the Seebeck or Poitevin processes of heliochromy on paper. Photo-bromide and photo-iodide have also been prepared, but they are not so colour-sensitive as the photo-chloride.

PHOTO-ALGRAPHY

The application of photo-mechanical reproduction processes to aluminium lithographic printing.

PHOTO-AQUARELL

Photogravure printing in colours by inking the plate locally with tampons, masks being used to indicate the portion to be inked.

The term has also been applied to a lithographic process of printing in colours from three etched stones.

Also a process of making coloured photographs on Whatman paper.

PHOTO-AQUATINT

A modification of the photogravure process, worked out by Thos. Huson, R.I., and fully described in his book entitled "Photo Aquatint." The principal difference between this process and ordinary photogravure is that, instead of using different densities of etching solution, practically only one strength is used, and the negative, transparency, and carbon resist have accordingly to be adapted to the process.

PHOTO-AUTOCOPYIST (See "Autocopyist.")

PHOTO-AUTOGRAPHY

A process of printing from lithographic stones on etched plates in colour, the image being applied by photo-mechanical means.

PHOTO-BIOSCOPE

An instrument constructed on the lines of the thaumatrope, and invented by Chevalier Bonelli, of Milan, in 1867. By its means both stereoscopic and cinematographic effects could be produced.

PHOTO-CERAMICS (See "Ceramic Process.")

PHOTO-CHROMATIC

One of the terms applied to the process of photography in natural colours.

PHOTO-CHROMATIC PRINTING

A process for printing photographically upon textile fabrics, the invention of R. Smith, of Blackford. The fabric is treated with a sensitive solution, and is wound off a roller, passing under a glass plate on which the design has been drawn ;

the material is thus exposed one section at a time, then passing through guiding rollers to a fixing trough, finally being washed. According to the fixing solution used, various colours are obtained. To produce a design pale blue on a white ground, or white on a blue ground, solutions of the citrate or tartrate of iron with potassium ferrocyanide are used. Brown or buff tints are obtained with a solution of potassium bichromate. The fabric is afterwards plunged in a dilute solution of sulphuric acid.

PHOTOCHROME PROCESS

A method of lithographic colour printing worked out and operated by the firm of Orell Fussli, Zurich. It is believed to be a process of printing a bitumen film on stone under a continuous tone negative, and treating in such a way that a reticulated grain image is formed.

PHOTOCHROMOSCOPE

A name by which the kromskop was at one time known.

PHOTOCHRONOGRAPHY

Chrono-photography, which is described under its own heading.

PHOTO-COLLOGRAPH

A term applied to any kind of collotype print, especially to prints made by Albert's photo-lithographic process.

PHOTO-COLLOGRAPHIC PROCESS

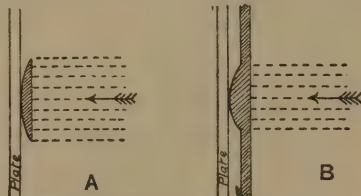
A synonym for collotype, but it has been more particularly used by the inventor of the Sinop photo-collographic process.

PHOTO-COLLOTYPE

A synonym for collotype or photo-collography.

PHOTO-CORRECTOR

An arrangement for preventing distortion in portraits, invented by H. Van der Weyde in 1892. It consists in the employment of an additional lens immediately in front of the plate, as shown in the diagram. The dotted



Two Forms of Photo-corrector

lines indicate light rays proceeding from the lens and falling upon the plate. Local reduction of size is produced by placing a plano-convex lens close to the plate and covering the part to be reduced. Used as at A, a halo would appear on the plate round the lens, and to overcome the difficulty the lens is embedded in a sheet of glass (see B) as large as, or larger than, the plate. By using lenses of different shapes and sizes—plano-concave and plano-convex—it is possible to produce a variety of effects. The accessory has not come into general use.

PHOTO-CRAYON

A style of portrait at one time popular; originated by Sarony, of Scarborough, in 1870. A transparency was made upon glass, finished in the usual way, and backed up with white paper on which crayon colours had been placed, the effect being that of a coloured photograph.

PHOTO-DYEING (See "Phototincture.")**PHOTO-ELECTRICITY** (Fr., *Photo-électricité*; Ger., *Photo-elektrizität*)

Electrical phenomena excited by the action of light. The converse—optical phenomena set up by electrical action—are classified as belonging to electro-optics. Modern research leads to the conclusion that light and electricity are identical, a fact first asserted in 1864 by Clerk-Maxwell, according to whom light waves are due to magnetic and electric strains in the ether that pervades space. Maxwell prophesied that, under suitable conditions, magnetic waves could be propagated through space with the same speed as those of light. This was experimentally verified by Heinrich Rudolph Hertz, in 1888, who proved the existence of electrical waves, of similar velocity to those of light, and, although invisible, capable likewise of reflection, refraction, diffraction and polarisation. These waves were turned to practical account in G. Marconi's system of wireless telegraphy (1895). In the same year Konrad Wilhelm Röntgen showed that invisible electric rays of another kind—the X-rays—were able to penetrate opaque substances, forming an image or shadow on a photographic plate. A familiar instance of an electrical effect influenced by light is afforded by the behaviour of selenium, the resistance of which to the passage of an electric current is greatly reduced when light impinges on it—a fact utilised for the telegraphic transmission of photographs.

PHOTO-ELECTROGRAPH (Fr., *Photo-électrographie*; Ger., *Photoelektrograph*)

An apparatus used by meteorologists to obtain a photographic record of variations in the electrical condition of the atmosphere, as indicated by the movements of a sensitive gold-leaf electroscope.

PHOTO-ELECTROTYPE (See "Electrophototypy" and "Electrotyping.")**PHOTO-ENGRAVING, AND PHOTO-ETCHING**

Synonymous terms applied generally to line and half-tone etching; fully discussed under many separate headings.

PHOTO-FILIGRANE (See "Filigrane.")**PHOTO-GALVANOGRAPHY** (See "Galvanography, Photographic.")**PHOTOGASTROSCOPE** (Fr., *Photogastroscope*; Ger., *Photogastroskop*)

An instrument employed in surgery for photographing the interior of the stomach, by means of a tube introduced down the throat and having a small electric lamp at one end

to furnish the necessary illumination. Mirrors are utilised to transmit the image to the camera, an air supply tube inflates the stomach, and the lamp is kept cool by a water-circulating device.

PHOTOGENE

The name given by Gaudin in 1861 to a sensitive preparation made by him for coating upon glass or paper. "The name," he stated in *La Lumière* (April 15, 1861), "can be applied to any sensitive compound containing iodide of silver with excess of free nitrate of silver." He prepared photogene by dissolving silver nitrate in hot alcohol with a little water, adding it to collodion, and finally adding a few drops of iodised collodion. It was not satisfactory.

The word was also used by J. Moule to describe a pyrotechnic compound for burning in his lamp (patented February 8, 1857) for the purpose of taking photographs at night. The powder was composed of pure and well dried potassium nitrate 15 parts, flowers of sulphur 5 parts, powdered antimony sulphuret 1 part, and powdered red orpiment 2 parts. After well mixing, the powder was passed through a fine sieve.

PHOTOGENIC DRAWING, OR PHOTOGENY

The name given by Fox Talbot in 1835 to the results of his early experiments, which consisted in coating paper or white leather with a silver nitrate solution and obtaining thereon, by the action of light, images of leaves, etc. Talbot communicated his experiments and showed examples of his photogenic drawings to the Royal Society, on January 31, 1839, six months prior to the publication of Daguerre's process. The following description of the process of producing photogenic paper is adapted from his own words. Paper of a good, firm quality and smooth surface is dipped into a weak solution of common salt and water (25 grs. to the ounce) and wiped dry, by which means the salt is uniformly distributed. A solution of silver nitrate is spread on one surface only, and dried before a fire. This paper, if properly made, is suitable for all photogenic purposes. A sheet thus prepared is washed with a saturated solution of salt and then dried. It will be found, especially if the paper is kept for some weeks before the trial is made, that its sensibility is greatly diminished, and in some cases is quite extinct. But if it is again washed liberally with the solution of silver, it becomes again sensitive to light, and even more so than it was at first. In this way, by alternately washing the paper with salt and silver and drying, Talbot succeeded in increasing its sensibility to a degree that is requisite for receiving the images of the camera obscura. The prints were fixed in a strong solution of common salt, or in a solution of potassium bromide or iodide. Later improvements resulted in the introduction of the calotype process (*which see*).

PHOTOLYPHIC ENGRAVING, OR PHOTOLYPHY

A process of photogravure invented by Fox Talbot, but now entirely superseded by the Talbot-Klic process. The metal plate was coated with gelatine, sensitised with potassium bichromate, and exposed to light under a negative. It

was then dusted with finely powdered copal resin and warmed until this melted. When cold, the plate was treated with a suitable etching fluid, which soaked through those portions of the film unacted upon or only partially acted upon by light, attacking the plate underneath in proportion to the varying thickness and hardness of the gelatine.

PHOTOGLYPTIE

The French name given to the Woodburytype process.

PHOTOGRAM

By some people considered the correct name for a photographic picture of any kind. They contend that "graph" is a termination indicating the active verb, whereas "gram" indicates the noun. For example, "telegraph," to write at a distance; "telegram," the writing made at a distance. Several attempts have been made to oust the older term, but with small success.

PHOTOGRAMMETRY (Fr., *Photogrammétrie*, *Métrophotographie*; Ger., *Photogrammetrie*, *Messbildverfahren*)

The science of measuring and surveying by the aid of photography. The camera is extensively used in the preparation of maps and for other topographical purposes. With a high-class lens free from distortion, a rigid camera and stand, and a fixed vertical position of the plate with regard to the lens, the size and arrangement of objects in the negative will bear a constant ratio to those of the original subject. If two or more photographs are taken, for instance, of any prominent building or natural feature from different standpoints, noticing carefully the part of the compass to which the camera is directed in each case, it is possible by means of the various points appearing in the resulting negatives or prints, and by a series of triangulations, to draw an accurate dimensioned plan. The camera for photogrammetric purposes is generally provided with levelling screws and a graduated circular scale at the base, while four fixed points are arranged at the back to register on each plate exposed the position of the horizontal line and of the lens axis. It is usual, also, for a magnetic compass and a theodolite to be attached to the camera.

The subject is too large to treat otherwise than briefly, but a few of the simpler formulæ used in photogrammetry may be quoted. It is assumed that the lens is at its principal focal distance from the plate and that the camera back is strictly vertical. Let O = height of object, I = height of image in negative or print, F = focal length of lens, and D = distance of object from lens, measured from nodal point. Then, to find

height of object, $O = \frac{I D}{F}$. The width may be found in the same way, provided the plane of the object is known to be parallel to the focusing screen. If the size of the object is known the distance may be calculated, $D = \frac{O F}{I}$.

The distance and size of an inaccessible object may be found by taking two photographs at a measured distance apart, but each in line

with the object—i.e. the latter should be central in both negatives. The distance apart may be measured either from the nodal point of the lens, or more conveniently from the focusing screen. Let S = the distance between the two standpoints, and I_1, I_2 = the heights of the two images in the photographs, then $O = \frac{S \times I_1 \times I_2}{F \times (I_2 - I_1)}$; while $D = \frac{O F}{I_1}$ or $\frac{O F}{I_2}$.

PHOTOGRANULOTYPE

An American process of graining an ordinary photographic negative by the application of the air brush, so that a granular negative image was obtained for printing on stone or metal.

PHOTOGRAPHY

The art of obtaining images by the chemical agency of light upon sensitive surfaces. The word itself cannot be traced farther back in English literature than the title of a paper read before the Royal Society by Sir John Herschel on March 14, 1839. Derived from $\phi\omega\tau\omicron\varsigma$, genitive of $\phi\alpha\omicron\varsigma$ or $\phi\omega\varsigma$, "light," and $\gamma\rho\acute{\alpha}\phi\omega$, "I draw." Hermann Schnauss, however, states that Nicéphore Niepce was the first who used the word photography, who indeed created it. On May 9, 1816, Niepce wrote to his brother Claude that it is not necessary that there should be bright sunshine when *photographing* objects out of doors.

PHOTOGRAVURE (Ger. and Fr., *Heliogravure*)

The process of photogravure as now generally understood and practised is that known as the Talbot-Klic process. Talbot's original method (see "Photoglyphic Engraving") with modifications is still worked in France. The following is an outline of the photogravure process:—A well-cleaned and polished copper plate is put into a dusting box, in which it receives a deposit of a fine dust of asphaltum or resin, which is next fixed by heating. A piece of carbon tissue is printed under a transparency and transferred to the grained copper plate on which the image is developed, and, when dry, etched with ferric perchloride in successive baths of varying degrees of strength (from 43° down to about 33° Beaumé). The weaker solutions penetrate the gelatine the most easily. After clearing off the resist the plate is seen to be etched in different depths in proportion to the tones of the picture, the shadows being deepest and consequently holding most ink. The plate is inked and printed from in the usual copper-plate manner.

PHOTO-HELIOGRAPH

A combination of telescope and camera used in solar photography. The exposure is made by the passage of a narrow slit.

PHOTOHYALOGRAPHY AND PHOTO-HYALOTYPY

Processes based on the transfer of the colloid image, described by G. Scamoni, of St. Petersburg. (See also "Hyalography.")

PHOTO-LITHOGRAPHIC TRANSFER PAPER

Paper coated with hardened gelatine for sensitising with potassium bichromate in order that

it may be printed under a negative to form a transfer. Ready-made photo-lithographic papers of excellent quality are obtainable, those of Jaffé, Albert, and Husnik being among the best known, and it does not pay the worker to prepare his own paper. The double transfer paper used in carbon printing answers well for transfers.

PHOTO-LITHOGRAPHY

Under this term is included a large number of processes which may be classified into two leading divisions—namely, transfer processes and direct processes, both of which may be subdivided into line and half-tone.

The transfer processes are all based on the principle that light acting on a bichromatised colloid, such as gelatine, will render the lines or other elements of the image capable of attracting greasy ink, whilst the other parts will repel it. The simplest method is to coat a good tough paper, such as bankpost, with gelatine, and after drying immerse it in a bath of potassium bichromate (usually about 5 per cent. strength). When dry, this sensitised paper is exposed under a line negative for a sufficient time. The paper is then thinly coated with transfer ink applied with a roller. On immersion in water, and by gentle rubbing with a tuft of cotton-wool, the surplus ink comes off, leaving the image in lines of ink. The print is dried, and is then ready for transferring to stone or metal. For half-tone work the paper may be exposed under a negative made through a ruled screen, or the half-tone may be formed by means of a reticulated grain, as in the papyrotint process.

In the direct process the stone or metal (usually zinc) is prepared with a sensitised coating of bichromatised glue, gelatine, or albumen, or with bitumen, exposed under either a line or half-tone negative, inked over if a bichromatised film, and developed with water; if a bitumen film it need not be inked, and it is developed with turpentine. The bitumen attracts the greasy ink so that the image can be rolled up for printing. To obtain grained half-tone images, various ingredients are added to the colloid coating, as in the papyrotint or Pretsch processes; or, in the case of bitumen, the image may be made to reticulate by dissolving the bitumen in a mixture of ether and alcohol.

In several processes of photo-lithography the image is prepared on a glass or metal plate similar to collotype, and transfers are pulled therefrom for re-transfer to stone or metal.

PHOTO-LITHOPHANE

The production of photographic transparencies from semi-transparent material (porcelain), the lights and shades of which depend on the greater or lesser thickness of the material employed. The photographic part in this process consists in the production of a swelled chrome-gelatine relief from a photographic negative, and a plaster-of-paris cast from it. The rest is done by the porcelain worker.

PHOTO-MECHANICAL PROCESSES (Fr., *Procédés photomécaniques*; Ger., *Photomechanische Verfahrenen*)

A term applied to all processes in which the action of light upon chemical substances is the

means of preparing printing surfaces, from which many impressions can be made without any further assistance from light action. Generally, the photographic image is made capable of giving impressions in greasy inks by typographic or lithographic methods, but the term also includes Woodburytype, although the printing in this case is not done with greasy inks. Particulars of photo-mechanical processes will be found under the headings of "Collotype," "Photolithography," "Photogravure," "Half-tone Process," etc.

PHOTO-METALLOGRAPHY

A term applied to processes of printing from photo-mechanical images on zinc or aluminium by the lithographic method.

PHOTOMETER (Fr., *Photomètre*; Ger., *Photometer*)

An instrument for comparing the intensity of two light sources. (See "Sensitometry.")

PHOTOMETRY (See "Sensitometry.")

PHOTO-MEZZOTINT

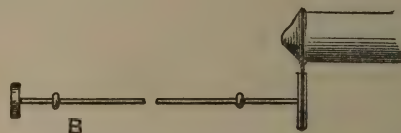
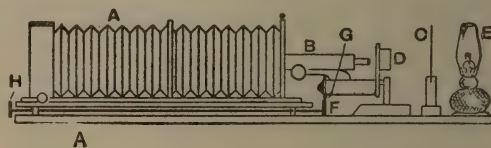
A name given to the gum-bichromate process of Maskell and Demachy.

PHOTO-MEZZOTYPE

A fancy name for one of the early half-tone processes.

PHOTOMICROGRAPHY

The photography of minute objects by the aid of the microscope. The essential apparatus includes microscope and stand, lenses and camera, and it may be said that many kinds of hand cameras can be utilised. A stage or base-board is necessary to receive the microscope and camera (with lens removed), which are placed in position on the stage as shown at A. A small platform is fixed on the stage to bring the lens



Arrangement for Photomicrography

flange of the camera, A, to the level of the microscope tube when the latter is brought over to a horizontal position. If a fairly long camera extension is used, the fine adjustment of the microscope will be out of reach of the hand; consequently a connecting-rod will be necessary for focusing purposes. A brass rod, B, fitted with a grooved wheel at one end and a milled head disc at the other may be fixed on the camera stage; the grooved wheel, F, is placed immediately

beneath the fine adjustment of the microscope and the milled head disc, H, below the focusing screen of the camera. A band or small strap G is placed over the groove of the fine adjustment of the microscope, and passed round the groove in the connecting-rod wheel. The image can then be focused by turning the milled head below the focusing screen. If the camera has a short bellows extension, no connecting-rod will be necessary, as the fine adjustment can be reached by the hand while the operator examines the image on the focusing screen. When transparent objects are photographed the light is placed behind the camera stage in a direct line with the objective and focusing screen. For low power work, an oil lamp, E, is a convenient illuminant. With high powers, the Nernst, incandescent gas, or acetylene lamp is preferable. As the mirror is not used, some kind of condenser is necessary to focus the light on the object. If no sub-stage condenser, D, is available, a bull's-eye condenser will answer the purpose.

For experimental purposes some well-mounted object with which the operator is perfectly familiar should be selected. Failing this, the wing of a house fly can be mounted (dry), and being very transparent, with opaque lines, is easily focused. An objective of low power should be used. The object is placed on the stage and focused; the eyepiece and draw-tube are removed, and the microscope brought over to a horizontal position. The inside of the tube must be lined with black paper, or the light reflected from the microscope tube will be found to give a flare spot on the plate. The microscope is now placed in position on the baseboard with the body-tube, B, projecting into the lens flange of the camera, the camera lens of course being removed. The photograph can be taken with the eyepiece in the microscope, but the consequent loss of light is considerable, and the difficulty of focusing proportionately increased. The lamp is placed in position behind the microscope, and the light is focused by the condenser on to the object.

When the focusing screen is examined no image of the object may be visible. The coarse adjustment is turned slowly to bring the objective nearer the object, and, when the image appears, sharp focus is obtained by means of the fine adjustment. If the lamp and condenser are properly arranged, the image will appear brightly and evenly lighted. If there is any unevenness of illumination, the position of lamp and condenser must be readjusted.

When the operations of arranging the illumination and focusing are completed, a dry plate is inserted in the dark-slide and a trial exposure made. No definite rules can be given for calculating exposure, but the following data of a trial exposure will assist the beginner in forming an estimate:—

Object photographed, head of gnat larva, clear specimen, mounted in Canada balsam; oil-lamp, $\frac{3}{4}$ -in. wick; objective, $\frac{3}{8}$ in.; bull's-eye condenser, $1\frac{1}{2}$ in. diameter; distance of object from focusing screen, 26 in.; distance of flame from object 7 in.; rapid plate; exposure, 10 seconds.

For photomicrography with high powers, a sub-stage condenser, a more powerful light, and for critical work a projection eyepiece are necessary. Colour filters, C, are often of great assistance

in photomicrography, especially when, as sometimes happens, the visual and actinic foci of the objective do not coincide. In the older types of objectives this fault was not uncommon. A yellow screen will overcome this difficulty, but except orthochromatic plates are used, the exposure is unduly prolonged. Objects which have been stained with a blue or violet dye should always be photographed with a yellow screen. When opaque objects are to be photographed, unless the objective is furnished with a Lieberkühn, the light must be placed at the side of the object, upon which it is focused by means of a bull's-eye condenser. A strong light is necessary, and unless a Nernst or incandescent gas lamp is available magnesium wire should be used.

A Lieberkühn is a parabolic mirror, named after the inventor, for illuminating opaque objects. It is fitted on to the objective, which projects through the centre of the mirror.

The approximate comparative actinic values of the various illuminants are as follow:—Oil lamp, $\frac{3}{4}$ -in. wick, 1; incandescent gas (new mantle), 15; Nernst, 20; acetylene, 30; arc lamp, 5 amps., 1,000; magnesium ribbon, 1,500. The oil lamp is somewhat feeble, and its yellow colour is a serious drawback. Incandescent gas is convenient, but in critical work some difficulty is caused by the pattern of the mantle. Acetylene gas gives perhaps the best all-round light, but the trouble of manufacturing the gas before beginning work militates against its popularity. The arc lamp is excellent; small arc lamps for use with an ordinary 16 c.-p. plug and switch are now available. The Nernst lamp, with its small bright flame, gives an excellent light, but the filaments are fragile and are liable to give a troublesome image. The metallic filament electric lamp gives a fairly actinic light, but the long zigzag filament is a serious objection to its use. The use of ground glass or tissue paper to obviate the formation of a pattern is not satisfactory, as direct rays from a small illuminating area are essential.

Transparent objects or sections are photographed by transmitted light; opaque objects by reflected light. In the former case the source of light is placed in a direct line with the objective and object, and the light, brought to a focus by some form of condenser, passes through the object into the lens. In the photomicrography of opaque objects the light is concentrated by means of mirrors or condensers upon the object, and is reflected by the object into the lens. Opaque objects require a much more powerful illuminant than transparent ones, and the difficulty of obtaining sufficient light renders the work extremely difficult. A method of illuminating opaque objects which is especially useful for high powers is by means of a cover-glass fixed diagonally inside the tube of the microscope. The light reaches the cover-glass through an aperture in the side of the body tube, and is deflected, from the surface of the glass, through the objective to the object, which reflects it through the microscope to the camera. Thus the light has to pass twice through the objective, in this way producing much scattered light, which mars the brilliancy of the image.

J. I. P.

PHOTOPHANE (Fr. and Ger., *Photophane*)

A fancy name given to the collotype process as worked by a London firm.

PHOTOPLASTIC

An electrotype obtained from a chromated gelatine photo-relief. (See "Galvanography, Photographic.")

PHOTOPOLYGRAPHY

A process resembling pinatype, but much older, having been described in 1897. A glazed paper is coated with gelatine, sensitised in a bichromate bath, dried, printed under a negative, and washed. The outstanding relief is stained with methyl violet, and the dyed image transferred by pressing into contact with ordinary paper.

PHOTOTOPOGRAVURE

The reproduction of maps by photographic means.

PHOTORADIERUNG

A German name for a process of coating a negative with a yellow varnish and scratching, with an artist's etching needle, through the film in lines which interpret the tones of the photograph. The numerous processes of this kind put forward may be classified under the term of "factitious negatives."

PHOTO-RELIEF ENGRAVING

A term given to processes in which, by photography and subsequent manipulation, a printing surface is obtained in which the parts receiving ink stand up in relief like type characters. Thus line and half-tone etched blocks may be said to be photo-relief engravings, but the term is properly applied to processes of making a hardened gelatine relief which may be printed from as in the Pretsch process, Dallas process, Husnik's Leimtype, and the swelled-gelatine process. The Woodburytype process is often termed a photo-relief one, although here the image itself is in relief, the printing block being an intaglio one. The acrograph process may be correctly described as photo-relief engraving.

PHOTO-ROSCOPE

An instrument on the old peep-show principle, for enabling a number of persons simultaneously to view animated photographs in daylight.

Also the name of a particular make of kinematograph machine invented by W. C. Hughes.

PHOTO-SCULPTURE

A term which had its origin in 1863, when the sculptor Willème, of Paris, patented his process and set up a studio for the work. He photographed his models with a number of cameras placed at the sides and top of a kind of building having a cupola; and he afterwards utilised the photographs in constructing the model, employing pantographs in order to facilitate his work. Poetschke, in 1891, improved the process, and Selke, a year later, substituted for the ordinary photographic apparatus the kinematograph, and projected on to the sitter a shadow which advanced progressively in the direction of the kinematographic camera. In this manner, ac-

cording to Carlo Baese, the apparatus registered a considerable number of silhouettes corresponding to the number of parallel planes in the model. Each of these negatives, about 500 in all, had to be enlarged separately upon bromide paper, and each was then pasted upon card and cut out with scissors. When these silhouettes had been cut into sections, they were stuck one over the other, and so built up, it is said, to form the portrait, but exactly how it was done has not yet been made clear. The use of bichromated gelatine (discovered in 1851) is more satisfactory. (See "Relief, Photographs in.")

For artificial reliefs—that is, prints that appear to be in relief—see "Plastic Photographs." Carlo Baese, who has paid particular attention to the production of portraits in the form of medallions, works on the lines described under the first named heading, and secures better modelled effects than are possible in the ordinary way, by the use of an optical lantern and mirrors, by which he projects and reflects light upon certain parts of the face which it is desired to show in high relief. His process was described before the Royal Photographic Society, on October 11, 1910, and by its means wonderful results are obtainable.

The term "photo-sculpture" is also applied to a kind of trick photography. A sketch of a bust without the head is made, natural size, on a sheet of cardboard, which is then cut out or, preferably, a papier mâché arrangement may be purchased ready for use, and placed on a pedestal of a convenient height, the sitter being posed behind it in such a way that the living head "sits" realistically. A photograph is next taken. Parts of the image that are not required may be scraped from the dry negative, or a print is made, blocked out with black or red water-colour paint, and copied in the camera. Another method is to cover the parts (arms, etc.) of the figure not required with a black cloth. The background should be quite black, and it may be necessary to powder the hair, eyebrows, etc., to give them, in the photograph, the appearance of stone.

PHOTO-SENSITIVE

A term applied to a substance that is sensitive to light.

PHOTO-SPECTROSCOPY (See "Spectro-photography.")**PHOTO-STEREOTYPE**

A stereotype made from a plaster cast taken from a gelatine relief. (See "Swelled Gelatine Process" and "Wash-out Gelatine Process.")

The term has also been applied in America to a block made by reproducing a drawing obtained from a photograph by the bleaching-out process.

PHOTOSTONE

A photo-chromo-lithographic process worked by an English company some years ago. It is understood that transfers were pulled from a collotype plate and put down on as many zinc or aluminium plates as colours were required. These plates were worked on by artists to stop out or remove all but the parts required to print

the particular colour for which the plate was to be worked.

PHOTO-SURVEYING (See "Photogrammetry.")

PHOTOTEGIE

A process introduced by Cousté, in 1904, for making transparencies, and reversed or duplicate negatives. The negative should be exposed as usual and developed with any developer except pyro till the deepest shadows are seen on the back of the film; it is next well washed, and the following operations may then be conducted in daylight. Make up a solution of—

Hydrochloric acid	. 1 oz.	100 ccs.
Barium peroxide	. 250 grs.	57 g.
Water	. 10 oz.	1,000 ccs.

This should be mixed in a glass bottle, standing in cold water to keep it cool; add the acid to the water, and then the barium in small quantities at a time, with constant stirring or shaking. The developed negative (not fixed) should be immersed in this solution, which should be kept rocked. The film begins to dissolve gradually, and as soon as this has well begun the barium solution is poured back into the bottle and the negative placed in water. The gelatine and reduced (developed) silver slowly dissolve away, and should any of it stick it can easily be rubbed off with a pad of cotton-wool, or the finger tip, or the barium solution may be again poured on. The result is an image consisting of various thicknesses of gelatine and unreduced (undeveloped) silver salt. The last named can be dissolved out in an ordinary fixing bath, and after well washing, the film should be stained in a solution of dye. Or, if desired, the unreduced silver may be left in the film and redeveloped with any ordinary developer. For making duplicate negatives, it is first necessary to make a positive by contact and treat this in the manner described above, so as to reverse it—that is, turn the positive into a negative. The dyed gelatine relief serves as a negative or a positive as the case may be, the dense parts being dyed deeper than the clear parts where the gelatine is thin.

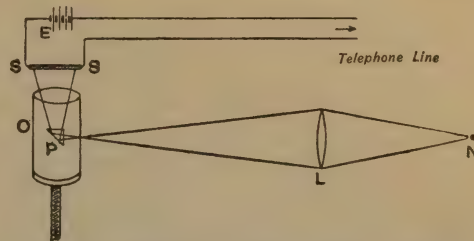
PHOTO-TELEGRAPHY

The transmission of a photographic image from one place to another by means of telegraphy. The idea of telegraphing pictures dates back to 1860, and even earlier, but it is only during the last few years that any successful results have been obtained commercially.

There are two systems which have been used extensively by newspapers: one is the invention of Prof. Korn, who was the first to produce a really practical system; the other is the invention of T. Thorne Baker.

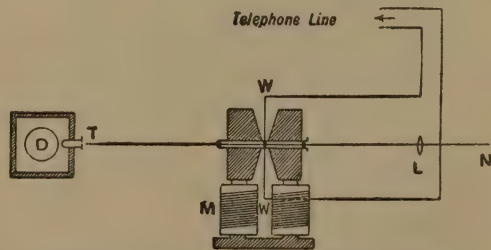
Professor Korn's Systems.—(1) By means of the original selenium process, the photograph to be telegraphed is printed as a transparency on celluloid, and this film is attached to a glass cylinder, C in diagram A. Light from a Nernst lamp N is made to pass, by the lens L, through the cylinder where the beam comes to a focus; what light passes through the cylinder reaches a prism P, and is reflected on to a selenium cell

ss. As the cylinder is rotated spirally (by means of a motor) different consecutive portions of the image intercept the light beams, and hence the intensity of the illumination falling on the cell ss varies. The cell has the peculiar property of varying in its electrical resistance, according



A. Transmitting Apparatus of Korn's Early Photo-telegraphy System

to the strength of light falling upon it; hence the current from an electric battery, E, which passes through the cell into the telephone lines connecting the sending apparatus with the receiver, also changes, and at the receiving apparatus, B, one gets an electric current varying in intensity each instant, according to the density of the photograph, as the image is traversed by the beam of light. The current received is passed through an exceedingly fine silver wire w suspended between the poles of a powerful electro-magnet M; to this wire is attached a small shutter, which cuts off a beam of light passing from a lamp N through lens L and a hole in the magnet poles. When a current passes through the wire w it is magnetically displaced, and light consequently passes through the magnet and arrives at a lens T, which concentrates it upon a sensitive film attached to a drum D; this drum rotates in a light-tight box synchronously with the transmitting cylinder, C in diagram A. The wire, w w, is displaced to a distance depending on the current, which itself is regulated by the density of the photograph at each instant. Hence, the light acting on the sensitive film varies always according to the density of the picture being transmitted. On developing the



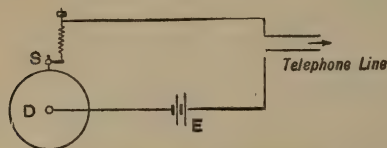
B. Receiving Apparatus of Korn's Early Photo-telegraphy System

film, a replica of the original photograph is obtained. There are, of course, various electrical complications in the process, but these need not be dealt with here.

(2) Prof. Korn's more recent apparatus is his telautograph, by means of which half-tone

photographs prepared with a single-line screen can be telegraphed. The photograph is printed in fish-glue on a thin copper sheet, developed, and attached to the metal drum, D, in diagram C.

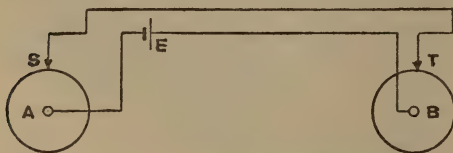
A metal stylus S traces a spiral path over the photograph, and as it travels over each glue line



C. Korn's Telautograph

the flow of current from a battery, E, through the cylinder and stylus is interrupted. The same form of receiving apparatus is used, but a great many improvements have been made in the galvanometer used, with the result that a picture 7 in. by 5 in. can be telegraphed in a few minutes, with as many as 150 lines to the inch.

T. Thorne Baker's System.—The telegraph has been largely used commercially between Manchester, London and Paris. Its great advantage over other systems is that it does away with the reception on a photographic film. The whole operation, therefore, is conducted in full light, and the image can be watched during its entire reception. A portable transmitter was designed in 1910 by the inventor, and this was used between Brighton and London in that year. The system is shown diagrammatically at D. A and B are the metal cylinders of the transmitter and receiver. A is provided with a steel stylus S, and B with a platinum stylus T. A half-tone single-line photograph printed on lead foil and pressed perfectly smooth is attached to A, and a piece of chemically prepared paper is wrapped round B. The battery E supplies the electric current. Whenever the steel stylus is in contact with the metal of the picture, that is, when it is not travelling over a glue line, current flows through the wires to the receiver, and a black dot appears under the stylus T. The original picture is thus reproduced, dot for dot, at the receiving machine, and a picture 8 in. by 5 in. can be transmitted in from ten to fourteen minutes. The system is explained here in its simplest form; in practice, the receiving apparatus is complicated, owing to the fact that the electric currents, in passing through long-distance wires, become lengthened in period and



D. T. Thorne Baker's Telegraph

changed in intensity, with the effect of distorting and blurring the received photograph. The various difficulties have been overcome by means of the line balancer invented by T. Thorne Baker, to which the success of a system based on many earlier attempts has been due.

PHOTOTINCTURE

Villain's process, invented in 1891, for the production of photographs on fabrics and paper by means of dyes. The fabric is sensitised by a few seconds' immersion in a solution of—

Ammon. bichromate	5 oz.	550 g.
Ammon. vanadate	240 grs.	55 „
Water	10 oz.	1,000 ccs.

The material is dried in the dark at a temperature not exceeding 75°F. (24°C.), for at 85°F. (29°C.) the transforming action begins and shows itself by veiling the whites. The dried material is exposed to daylight under a negative, the time being found by experiment, the image being visible, and washed to eliminate the chromium salt not acted upon by light, leaving the fabric mordanted where exposure has fixed upon it the chromium and vanadium oxides. Next the fabric is boiled in a dye bath, preferably of alizarine or purpurine, this being gradually heated to boiling point, at which it is maintained for fifteen minutes. The fabric is then washed and, if the whites are not pure, passed through a warm bath of soap and sodium carbonate, or a cold bath of chloride of lime to which has been added a few drops of hydrochloric acid, it being necessary before drying to drive out every trace of the acid by the use of a bath slightly alkaline. The fabric is finally washed and dried. The dyes fix themselves only on the parts where the mordant is fixed; and the parts where the light has not acted (high lights) will give the whites, unless the materials were impure or a mistake has been made. The colouring products used by Villain were the artificial alizarine sold under the name of alizarine for violet, alizarine for red; alizarine blue S; alizarine black S; galloflavine; purpurine; anthracene brown (anthogallol); alizarine orange; alizarine yellow A; alizarine chestnut; alizarine green S; alizarine blue indigo S, and galleine.

PHOTOTINT

A name given both to a collotype and a half-tone block process. Cocking's process of phototint consisted in printing from two negatives, one being an ordinary photographic negative and the other prepared by hand. Striking effects of light and shade were thus produced.

PHOTOTYPE

A name formerly given to a secret process of carbon printing invented by Joubert; has since been applied to collotype, and also to half-tone blocks.

PHOTO-TYPOGRAPHY

A general term applied in photography to a large number of processes in which relief printing surfaces for letterpress printing are produced by the aid of the chemical action of light.

PHOTO-VERROTYPE

A modification of the collotype process, worked about the year 1870.

PHOTO-XYLOGRAPHY

Processes of photographing on boxwood blocks as a guide for the engraver instead of drawing the image. The blocks may be prepared

with albumen and sensitised on a silver nitrate bath; or a silver emulsion may be spread on the block; or a carbon tissue may be developed upon it; or a film, developed on a glass plate, may be transferred to it; or a greasy ink transfer may be applied.

PHOTO-ZINCOGRAPHY

A process worked out by Col. Sir Henry James at the Ordnance Survey Office in Southampton, and at first simply a method of preparing a photo-lithographic transfer and applying it to a zinc plate, afterwards printed from. Direct prints from negatives are now made on the zinc plates, and the Vandyke process is largely employed for map and plan work. In this process the original drawing is printed through, instead of using a glass negative.

PHOTO-ZINCO PROCESS

Line etching on zinc was originally called by this name, but the term is not now often used.

PHOTO-ZINCOTYPY

Ordinary line etching on zinc.

PHYSICAL DEVELOPMENT

The formation of the image by chemical deposition on the film of the plate, instead of by a chemical decomposition of the haloid salts in the film, as is generally the case. For example, in the wet collodion process the silver image is not formed from the bromides or iodides in the film, but by reduction of the silver nitrate sensitising solution on the surface by the ferrous sulphate developer, the latent image forming in some way a nucleus for this deposition, although not itself reduced. Another instance is afforded by the possibility of developing a gelatino-bromide plate after it has been fixed, by means of an alkaline developer containing silver nitrate (*See also* "Fixing Before Development.")

PHYSIOTYPE

Nature printing from leaves, flowers, etc.

PICRIC ACID (*See* "Tri-nitro-phenol.")

PICTORIAL COMPOSITION (*See* "Composition, Pictorial.")

PIGMENT PLASTER

A paper coated with a mixture of soft gelatine and pigment. It resembles insensitive carbon tissue, and is used in the ozobrome process.

PIGMENT PROCESSES

Various printing processes in which the image is formed of a pigment primarily embodied in a sensitive support—for example, carbon, ozotype, gum-bichromate, and similar processes. A. L. Poitevin, in 1855, was the first to suggest the use of a pigment with chromated gelatine or its equivalent. J. Pouncy, of Dorchester, followed in 1858; he used a vegetable carbon with gum and potassium bichromate, and is supposed to have been the first to produce a really successful pigment (carbon) print. Beauregard patented a method of obtaining pigment prints in 1857. In the dusting-on process, pigment is applied after exposure.

PIGMENTING

Under the headings "Oil-pigment Process" and "Bromoil" have been indicated the means by which a print is obtained in gelatine relief, and in each case it remains to produce the actual picture by the application of a pigment or ink.

At least one brush of pole-cat hair, of fair size, is necessary, and smaller brushes will be found useful for local work. A small quantity of ink (a piece the size of a pea will be ample for even a 12 in. by 10 in. print) is taken and rubbed down with the palette knife on a piece of clean glass or opal until of such a consistency that it can be spread on the glass in a thin film. If the pigment is too hard it may be thinned down with a softer ink, or with a trace of megilp or Roberson's medium. A thick ink tends to give hardness and brilliance, a thin ink softness. Black and Venetian reds are useful pigments, as by their use colours can be obtained ranging from black, through warm black, sepias and browns, up to red. The print is pigmented on a support made as follows: The foundation is a sheet of glass or zinc, or a pulp slab; over this are placed two or three smooth sheets of wet blotting-paper; and on top is stretched a piece of damp muslin. The soaked print is placed on this, and the moisture removed from the gelatine surface by gently wiping with a moistened pad of soft linen. A brush is now dabbed once or twice on the film of pigment, and then on a clean portion of the glass. The object is to secure that each hair-tip holds a minute trace of pigment. The charged brush is then applied to the print with a gentle dabbing motion, and if all is right the image will gradually appear as the gelatine accepts or rejects the pigment in accordance with the light action that has taken place on the bichromated gelatine. The print must be worked upon patiently and systematically all over. It is best after each re-charging of the brush to work first on the stronger parts of the subject and then pass to the more delicate parts (such as the sky) when the pigment in the brush is diminished. Gentle brush action and a thin ink will cause the print to accept colour more readily than a more vigorous dabbing and thicker pigment. High lights may be brightened by taking a clean flat-cut brush and "bouncing" or "hopping" it vertically on to the print. The more patiently the ink is applied in small quantities by continued and gentle dabbing the finer will be the deposit and the better the gradations of tone. Variations in brush action, the use of pigment of a different consistency, the ability to lighten or strengthen parts locally, all provide means of exercising control over the final result. But the beginner would be well advised to direct his efforts at first to obtaining "straight" prints with a fine deposit and a full scale of gradations.

The finished print is hung up to dry. The ink will set almost as soon as the paper is dry, but the prints should be carefully handled until the image is thoroughly hardened. The brushes should be cleaned immediately after use. This is easily done by rubbing their surface on a piece of fluffless material moistened with petrol. The blotting-paper should also be dried after use or it will develop mould.

PIGMOIL

A somewhat inharmonious term invented to indicate the oil-pigment process (*which see*).

PINACHROME (*See "Isocyanines."*)**PINACHROMY** (*Fr. and Ger., Pinachromie*)

Koenig's three-colour printing process introduced in 1904 by the Hoechst Dye Works, founded upon the light-sensitiveness of the leuco bases of aniline dyes. These are colourless bodies formed by the reduction of dyes especially of the triphenyl-methane series, and differing from them by the addition of two hydrogen atoms; they oxidise, or in other words form dyes, much more quickly in light than in the dark. Ostwald Gros was the first to discover the light-sensitiveness of these bodies, and that they became strongly coloured, more especially by those rays which were complementary to the colour of the dyes from which the leuco bases were formed. The leuco bases were dissolved in collodion to which was added nitro-glycerine, nitro-mannite, or some other nitrogenous body, and then printed under the constituent negatives one after the other, a different leuco base being coated between each printing. The process is theoretically interesting but practically valueless, as the colours formed were not stable to light, and the stock leuco base solutions extremely fugitive.

PINACYANOL

A dye of the isocyanine group, used for colour-sensitising plates. It gives sensitiveness up to the extreme visible red.

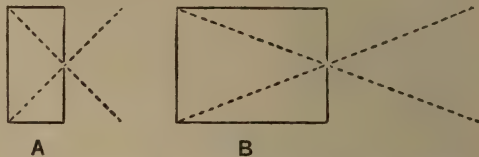
PINAKOL (*See "Amido-acetic Acid."*)**PINATYPE** (*See "Three-colour Photography."*)**PINAVERDOL** (*See "Isocyanines."*)**PINHOLE PHOTOGRAPHY**

Photography by means of a pinhole camera, that is, a camera in which (*see A*) instead of a lens there is a small hole made by a needle in a metal plate, card, etc. If a pinhole is pierced through one side of a light-tight box, the light rays proceeding from any object (say a candle flame) placed in front of the hole will form an image of the object on the opposite wall of the box inside; the size of the image depends upon its nearness to the camera, and its distinctness or definition depends upon the size of the hole. Photographs obtained through a pinhole possess a pleasing softness of outline, distortion is absent, and any angle may be included upon the plate, a wide angle by having the hole near the plate (*see A*) and a narrow angle by having the hole farther from it (*see B*). On the other hand, the definition is not critically sharp, and the necessary exposure is so long that it is impossible to photograph moving objects. Within certain limits a pinhole has no plane of focus, as proved by the fact that results practically as good as one another can be obtained by having the sensitive plate at different distances from the hole.

Any camera may be used for outdoor pinhole photography, as may also any light-tight box, but the former has the advantage that the distance between pinhole and plate is easily altered,

remembering that, while this is not necessary for focusing, the shorter this distance the greater the angle of view, and consequently the more of the subject included upon the plate. For indoor work, failing a regular camera, any light-tight box C may be used, the plate being supported by means of a printing frame or drawing pins.

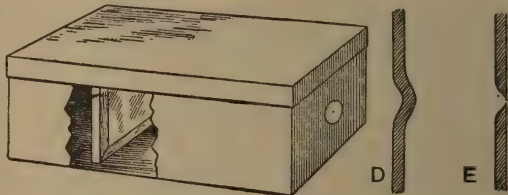
The pinhole must be circular, with perfectly



A Wide-angle and Narrow-angle Pinhole Cameras

clean edges without the slightest burr; at its edges the thickness of the material must be less than the diameter of the hole. The presence of a burr on the edge would give precisely the same effect as photographing through a tube, namely, to limit the angle included. A pinhole of $\frac{1}{16}$ in. diameter bears the same relation to metal $\frac{1}{16}$ in. thick that a 1-in. lens bears to a tube 4 in. long. The reflections from the interior of the hole in a comparatively thick plate of metal would also interfere with the brightness and definition of the image. Tinfoil is the material often used, but it is very fragile when mounted up in place of the lens. Many prefer to use thin brass, in which a boss (*see D*) has been made by means of a steel punch. The boss is rubbed or filed down and the pinhole made through the thinnest part (*see E*). The "pin"-hole is best made with a needle, which should be inserted gradually and alternately from both sides of the hole so as to obviate burr. Any other way of making the hole may be adopted as long as the result is a circular hole with clean edges.

The effect of the distance between plate and hole has been referred to. The diameter of hole should vary with the distance, and the rule proposed by Sir W. Abney is very useful in this connection. To find the diameter of the hole, divide the square root of the distance by 120. To find the distance, multiply the diameter of the hole by 120 and square the result. Thus, assuming the distance to be 25 in., the square root



C. Improved Pinhole Camera

Production of Pinhole in Metal Plate

is 5, and this divided by 120 equals $\frac{1}{24}$ in., which is the diameter of the required hole. In the case of a hole $\frac{1}{16}$ in. in diameter, the distance will be 9 in., since $\frac{1}{16} \times 120 = 3$, and $3^2 (3 \times 3) = 9$. But extreme latitude is possible because of the great depth of focus.

With regard to determining the diameter of the pinhole, it may be measured more conveniently if pierced with a needle of standard size. The following table is based on Abney's rule:—

Size of Pinhole	Distance of Plate from Hole	Ratio of Aperture to Focal Length or Distance
<i>in.</i>	<i>in.</i>	
$\frac{1}{16}$	$1\frac{1}{2}$	$f/150$
$\frac{1}{32}$	2	$f/180$
$\frac{1}{64}$	$2\frac{1}{2}$	$f/180$
$\frac{1}{128}$	3	$f/210$
$\frac{1}{256}$	4	$f/240$
	5	$f/250$
$\frac{1}{512}$	7	$f/315$
$\frac{1}{1024}$	9	$f/360$
$\frac{1}{2048}$	$11\frac{1}{4}$	$f/411$
$\frac{1}{4096}$	16	$f/480$
$\frac{1}{8192}$	23	$f/575$
$\frac{1}{16384}$	36	$f/720$

The following tables of needles, their sizes and diameters, are due to Messrs. Alfred Watkins and E. J. Wall:—

Hall & Co.'s Needles		Kirby & Co.'s Needles	
Number	Diameter	Number	Diameter
	<i>in.</i>		<i>in.</i>
1	$\frac{1}{32}$	2	$\frac{1}{32}$
2	$\frac{1}{32}$	3	$\frac{1}{32}$
3	$\frac{1}{32}$	4	$\frac{1}{32}$
4	$\frac{1}{32}$	6	$\frac{1}{32}$
5	$\frac{1}{32}$	7	$\frac{1}{32}$
6	$\frac{1}{32}$	9	$\frac{1}{32}$
7	$\frac{1}{32}$	10	$\frac{1}{32}$
8	$\frac{1}{32}$	12	$\frac{1}{32}$
9	$\frac{1}{32}$	16	$\frac{1}{32}$
10	$\frac{1}{32}$		

For most practical purposes pinholes of $\frac{1}{32}$ in., $\frac{1}{64}$ in., and $\frac{1}{128}$ in. will be sufficient, and they can be used at any distance from $1\frac{1}{2}$ in. to 30 in., although theoretically the respective distances are 5 in., $2\frac{1}{2}$ in., and $1\frac{1}{2}$ in. The largest hole will be useful for all out-door work, the medium hole for architecture, both interior and exterior, and the smallest for copying and short focus work.

The pinhole having no definite plane of focus it is obviously unnecessary to focus on a ground glass, but the photographer will need to know the amount of view included upon the plate. The amount of light coming through the pinhole is generally so small that it will not be easy to examine the image on the ground glass. By far the most practical plan is to take a piece of millboard just large enough to slide into the grooves in which the dark-slide is usually carried, and in the card to cut an aperture the size and shape of the plate used. If a half-plate is used in a half-plate camera there will be no need for the card, but smaller plates than the camera usually takes are often used for ex-

perimental pinhole work. Turn back the focusing glass from the camera, slide in the card (if necessary), direct the back of the camera towards the view, and look through the pinhole from the front. It is then possible to judge the suitability of the pinhole, and, by racking in or out, the amount of view included. Then swing round the camera, insert the plate, and make the exposure.

The usual method of exposing is to fit the pinhole in a pill-box arrangement, using the lid as the cap, or to fit a flap or revolving disc over the pinhole. In the first of the tables the ratio aperture ("stop value") is given for a certain extension of the camera; if any other extension is used the ratio aperture must be found by dividing the distance between pinhole and plate by the diameter of the pinhole. The usual law relating to exposure holds good, namely, that the exposure varies as the square of the aperture number; thus, if a lens working at $f/8$ requires a quarter of a second, with $f/600$ the exposure would be $\frac{1}{4} \times 600^2 = \frac{1}{4} \times 600 \times 600 = (\text{approx.})$

1,400 secs. = (approx.) 24 minutes.

The calculation of the exact exposure fortunately does not matter so very much, as, owing to the smallness of the aperture, there is an immense amount of latitude.

PINHOLE THEORY IN HALF-TONE WORK

The formation of the half-tone dot on the negative is explained in the pinhole theory, it being assumed that each opening in the network of the ruled screen acts as a pinhole.

PINHOLES IN NEGATIVES

Small transparent spots in the image and gelatine on the negative generally caused by dust. (See "Dust Spots.")

PINT

In British measure this is equal to 20 fluid ounces (160 drams, or 9,600 minims), and the eighth part of a gallon. In America the pint is equal to 16 fluid ounces (128 drams, or 7,680 minims). One pint (British) equals 568 ccs. and the American pint 454.5 ccs.

PIPETTE

A glass tube drawn to a point at one end; used for measuring small quantities of liquids. (See also "Dropping Tube.")

PITCHBLEND

Synonym, uraninite. A native ore containing uranium, helium, radium, and other rare elements. It is the main source of uranium salts.

PITCH, BURGUNDY

A resinous pitch used in etching inks and etching grounds. (See "Burgundy Pitch.")

PITCH, JEW'S

Bitumen of Judea or asphaltum (see the last named).

PITCH, MINERAL

A synonym for asphaltum or bitumen.

PITS IN NEGATIVES

Holes in the gelatine film on negatives, fortunately rare, but sometimes found after drying; they must not be confused with pinholes. They vary in size from a pin's-head to a threepenny piece, and usually appear at a time when the air is laden with moisture and the negatives take a long time to dry. They are said to be due to the decomposition of the gelatine, and the best preventive is to soak the negative after washing in a 10 per cent. solution of formaline.

PIZZIGHELLI'S PROCESS

In this is used a print-out platinum paper invented by Capt. Pizzighelli, of Vienna, in 1887. The exposure may be judged as accurately as with ordinary P.O.P., and development of the paper is unnecessary. Any good plain paper may be used, and the sensitiser may be as follows:—

A. Potass. chloroplatinite	734 grs.	168 g.
Distilled water	10 oz.	1,000 ccs.
B. Ammonium ferric oxalate	3½ oz.	412 g.
Powdered gum arabic	3½ "	412 "
Potass. oxalate (5 % sol.)	7 "	700 ccs.
Glycerine	100 mins.	21 "

Heat the potassium oxalate solution to about 115° F. (46° C.), and dissolve in it the ferric salt and glycerine; then add to the gum and stir well.

C. Solution B	3½ oz.	1,000 ccs.
Potass. chlorate (1 in 20 sol.)	135 mins.	80 "
D. Potass. oxalate (5 % sol.)	11 drms.	535 ccs.
Merc. chloride (5 % sol.)	338 mins.	200 "
Gum arabic (powdered)	370 grs.	242 g.
Glycerine	34 mins.	20 ccs.

C and D are sensitive to light and should be kept in the dark. For black images, sensitise the plain paper with the following:—

A solution (platinum)	100 mins.	100 ccs.
B solution (iron and gum)	120 "	120 "
C solution (gum and chlorate)	40 "	40 "

For sepia prints use—

A solution	100 mins.	100 ccs.
C solution	80 "	80 "
D solution	80 "	80 "

Lay the paper on a sheet of glass, working in a yellow light, and apply the sensitiser with a pad of cotton-wool. Dry quickly and preserve in a calcium tube. Print under a negative in daylight until the image is fully out, and then clear by passing through dilute hydrochloric acid (1 in 80); finally wash for from fifteen to twenty minutes in clear water.

The time of printing Pizzighelli paper may be shortened if, after the deepest shadows have appeared, the prints are developed in a cold 5 per cent. solution of potassium oxalate or common washing soda. The following bath has also been recommended in place of the hydrochloric acid bath: Copper sulphate, 154 grs.; water, 34 ozs. The Pizzighelli process cannot be depended upon for regular tones.

Pizzighelli also invented a paper of the "Pellet" type. (See "Pellet Process.")

PLAIN (SALTED) PAPER PRINTING

This employs a paper sensitised by immersing in a soluble chloride, and floated afterwards in a bath of silver nitrate. The paper is either only slightly sized or not sized at all, with the result that the original surface or texture of the paper is retained, and the prints appear to be on plain paper, hence the term. Such papers are printed out under a negative in daylight, and then toned and fixed. Good writing paper serves well for small prints and Whatman's or any other good drawing paper for large ones. When sizing is omitted some workers add just enough potassium bichromate to the salting solution to colour it faintly.

Arrowroot and gelatine sizes appear to be the most popular. For the latter use—

Gelatine	100 grs.	23 g.
Chrome alum	4 "	1 "
Ammonium chloride	50 "	11.5 "
Water	10 oz.	1,000 ccs.

The gelatine is soaked for thirty minutes in 8 oz. of the water (cold) and the chrome alum dissolved in the remaining 2 oz. The gelatine is next heated on a water bath, the ammonium chloride stirred in, the whole strained through fine muslin, the chrome alum solution poured very gradually into it, and the whole stirred. It is now ready for coating upon the paper, and should be stood in hot water to keep it fluid. The paper is pinned to a flat board or laid upon glass and weighted at the corners. The salting solution is sponged on as quickly and as evenly as possible, being finally gone over with a squeezed sponge to remove superfluous solution. Three minutes should be ample time in which to salt a 20-in. by 16-in. sheet; and the quantity of solution above given can be made to coat ten such sheets. They should be kept flat for a few minutes until the gelatine has penetrated, and then hung up to dry in a warm place. The prepared paper will keep good for several months.

When required, the paper is sensitised with a silver nitrate solution:—

Silver nitrate	600 grs.	138 g.
Citric acid	300 "	69 "
Distilled water	10 ozs.	1,000 ccs.

Sensitising is done in a weak or yellow light and the mixture is applied by floating, or preferably by brushing, and not by total immersion. Any brush used must be in wood and not in metal. Apply the sensitiser evenly and liberally, and hang the coated paper in a warm dark place for about ten minutes in order that it may become surface dry, and then repeat the application in order that there may be an excess of silver nitrate, which is necessary for rich and brilliant prints.

Printing can be done from almost any kind of negative, thin or flat ones being the least suitable. The prints lose but little in toning and fixing, therefore the printing need not be carried very far beyond the result desired. When taken from the printing frames, the prints should be well washed, say, for fifteen minutes, to remove the acid and free silver salt, and are then

ready for toning, for which any gold or platinum bath may be used if weakened with water, the following being specially recommended:—

Sodium acetate	.	30 grs.	4 g.
Gold chloride	.	1 gr.	13 „
Water	.	16 oz.	1,000 ccs.

Mix about twelve hours before use. Toning is very rapid, one minute's immersion giving, as a rule, the best brown or sepia tones. Over-toning is the commonest cause of failure, but as prints always dry a colder tone than they appear when wet, allowance should be made. The toned prints should be placed in a solution of $\frac{1}{2}$ oz. of common salt in 60 oz. of water, in order to stop the toning action; they are next washed for a few minutes, fixed for ten minutes in a "hypo" bath, and finally washed again.

Alternative Baths.—The following is a good sensitiser:—

Silver nitrate	.	600 grs.	138 g.
Water	.	10 oz.	1,000 ccs.

Add liquor ammoniæ drop by drop, until the precipitate first formed is dissolved.

The following sensitiser is suitable for papers sized with arrowroot; in the case of agar-agar papers the citric acid should be increased to 100 grs. or 117 g.:—

Silver nitrate	.	140 grs.	164 g.
Citric acid	.	55 „	64 „
Distilled water	.	2 oz.	1,000 ccs.

Alternative toning baths are as follows:—

1. Potass. chloroplatinite	20 grs.	4.5 g.
Nitric acid	10 mins.	2 ccs.
Distilled water	10 oz.	1,000 „

Tone and fix as usual.

2. Citric acid	36 grs.	8 g.
Common salt	12 „	2.7 „
Potass. chloroplatinite	1 gr.	23 „
Distilled water	10 oz.	1,000 ccs.

Tone and fix as usual.

3. Borax	30 grs.	7 g.
Gold chloride	$\frac{1}{2}$ gr.	1 „
Distilled water	10 oz.	1,000 ccs.

Use as soon as mixed; tone and fix as usual.

4. Sodium phosphate	10 grs.	2 g.
Gold chloride	$\frac{1}{2}$ gr.	1 „
Water	10 oz.	1,000 ccs.

Use as No. 3, above.

The following is a plain paper which may be called "self-toning," as excellent tones may be obtained simply by fixing in a $2\frac{1}{2}$ per cent. solution of "hypo"—say, 12 grs. to 1 oz. of water. The paper (without water-marks) is given an extra coating of size, made by rubbing up 90 grs. of arrowroot with 5 oz. of cold water, adding a solution of 20 grs. of glucose in 5 oz. of hot water, and boiling in an enamelled saucepan for two minutes. When cool, immerse the paper till thoroughly saturated, dry, and sensitise with

Nelson's gelatine	60 grs.	14 g.
Tartaric acid	80 „	18.5 „
Silver nitrate	90 „	21 „
Ferric ammonio-citrate	400 „	920 „
Water	10 oz.	1,000 ccs.

The solution, made as described earlier in this article, should be stored, if required, in a black bottle. After proceedings are as already described.

PLANAR LENS

A lens of symmetrical construction consisting of two three-lens combinations, two glasses of each being cemented and the third separated by an air space (*see illustration*). The smaller sizes are especially useful for photomicrography,



Planar Lens

while the larger ones are suitable for all classes of rapid work, portraiture, etc. There is an apochromatic series suitable for three-colour work. Planars are made by Zeiss in a range of focal lengths from $\frac{3}{4}$ in. to $18\frac{1}{2}$ in., while the intensity varies from $f/3.6$ to $f/6.3$.

PLANE TABLE (Fr., *Planchette photographique*; Ger., *Photographisch Messstisch*)

A panoramic camera invented by Chevalier and used in surveying by photography. A vertical lens fitted with a reflecting prism or mirror was made to revolve above a horizontal plate, a complete circular picture of the surrounding country being thus obtained. To prevent overlapping, a revolving disc with a narrow radial slit moved over the plate in synchronism with the motion of the lens, its centre being in line with the lens axis.

PLANES (Fr., *Plans*; Ger., *Flächen*)

The different positions or distances occupied by the various parts of a subject. The nearer planes contain the strongest light and shade and the most pronounced detail; as the planes recede, the detail, light, and shade become less apparent. The adequate rendering of the values of the various planes produces good aerial perspective. Lighting and the state of the atmosphere influence the tone and quality of the planes. Lack of differentiation between one plane and another gives an appearance of flatness.

PLANISCOPE (Fr., *Planiscope*; Ger., *Planiskop*)

A series of supplementary lenses intended to be placed in front of an ordinary camera lens, to shorten or increase the focal length. Four different kinds are obtainable, for wide-angle, copying, portrait, or telephoto work respectively, and each consists of a single achromatic lens mounted in a metal rim provided with two bow springs, by means of which the planiscope may be fitted on the hood or body of the camera lens.

PLANO-CONCAVE LENS (*See "Concave Lens."*)

PLANO-CONVEX LENS (See "Convex Lens.")**PLANT LIFE, PHOTOGRAPHY OF**

The life history of a plant from the first shoot to the mature growth, the opening of a leaf-bud, and the unfurling of the leaves, the expansion of a blossom, and the various types of fruits are examples of plant life that will yield interesting photographs. A rigid stand camera provided with a long extension of bellows is the most suitable all-round instrument for the work, and quarter-plate size will be found generally useful. The lens should not be of less than $5\frac{1}{2}$ in. focal length for a quarter-plate, and a lens of 6 $\frac{1}{2}$ in. or 7 in. focal length would give more natural perspective. If an anastigmatic lens working at $f/5$ or $f/6$ is not too costly, it should be used, since its large aperture is of great advantage when working out of doors, though it must be remembered that the larger the aperture, the less the so-called depth of focus, and, therefore, the greater care is necessary in focusing the object. A rapid rectilinear lens will answer very well for indoor work, and for the field in bright weather. The most useful type of shutter is one that can be fastened to the front of the camera, and is fitted with removable lens panels, so that lenses of different focal lengths can be quickly placed in position. Orthochromatic plates should always be used, and generally a yellow filter is desirable, especially for flowers. If much flower work is contemplated, obtain a set of three filters—a pale yellow, a medium, and a heavy one, such as Wratten's K_I, K_{II}, or K_{III}. A panchromatic plate will generally be found to yield the best results with flowers, but some skill and judgment will be required in the selection of the filter to be used.

The autochrome process of colour photography lends itself particularly to photographing flowers, and most beautiful results may be obtained, showing every delicate shade of colour.

PLAQUE PHOTOGRAPHY

A method in which prints were given a concave shape with the object of imitating the appearance of a porcelain plaque. The print was pressed whilst wet between rubber covered dies respectively of convex and concave shape.

PLASTER CASTS FROM PHOTO RELIEFS

Numerous processes have been based on the principle of obtaining a relief in chromated gelatine, and taking therefrom a plaster cast, which might be used by itself as a plaque for decorative purposes, or be the means for obtaining a porcelain plaque, or for making an electrotype or stereotype. (See "Galvanography, Photographic," "Gelatine Reliefs," "Photolithophane," "Photo-stereotype," etc.)

PLASTIC PHOTOGRAPHS

Photographs upon flat glass or paper and giving the effect of bas-reliefs. A negative of the subject is made in the usual way, then a transparency (positive) by contact from the negative, and when the positive is dry it is again placed in contact with the negative (film to film). On being held up to the light, one of the plates is

shifted very slightly to one side, so as to be a trifle out of register, and the two are bound together and then framed, printed from, or copied in the camera. Profile portraits give the best results. The effect is due to one side of the image being represented as a white line and the opposite side as a dark one, just as a bas-relief would be if illuminated by a strong side light.

PLATE

A term loosely applied, but generally understood to mean a dry plate. When the plate has been exposed, developed, etc., it is known as a "negative," "positive," "transparency," etc., as the case may be.

In process work, the term "plate" is generally applied to the surface to be printed from, and also to the actual print from the plate, as illustration plates in books, and plates for framing. Plate-printing is distinguished from letterpress or lithographic printing by its understood reference to printing from intaglio, etched, or engraved copper and steel plates.

PLATE ADAPTERS

The name given to various kinds of dark-slides which render possible the daylight loading and changing of plates, in light-tight envelopes or in other ways. In addition, the term is often applied to accessories which enable plates to be used in cameras intended for films. (See also "Plate Carrier.")

PLATE BACKINGS (See "Backings, Plate.")**PLATE CARRIER**

Also known as an adapter. A light frame of wood or metal fitting inside a dark-slide and permitting the use of a smaller plate than that

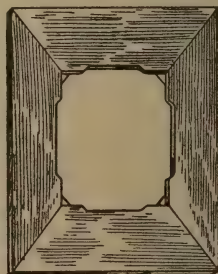


Plate Carrier

for which the slide is made. The illustration shows the usual form. Large slides are frequently fitted with a nest of carriers.

PLATE CHANGING (See "Daylight Changing.")**PLATES, COATING** (See "Coating" and "Emulsion.")**PLATE HOLDER** (Fr., *Porte-plaque*; Ger., *Plattenhalter*)

A clip of metal, celluloid, or other material, used for holding and lifting plates during development, washing, etc., in order to avoid touching them or immersing the fingers in the

solutions. A typical pattern is illustrated. (See also "Pneumatic Holder.")

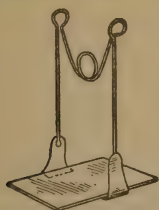


Plate Holder

This term is also often applied to the dark-slide, plate-adaptor, and, indeed, to anything else that contains, holds, or supports plates.

PLATE LIFTER

A kind of lever of metal, ebonite or celluloid, used for raising plates from the developing or other solution, in order that they may be

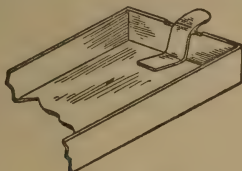


Plate Lifter

examined or removed. Some developing dishes have a lever attached at one side, as illustrated. The device is made in many forms, and the term is also often applied to the plate holder.

PLATE MARK

The indentation made in paper by the metal plate when printing engravings, etc. Some mounts for photographs have a similar impression made upon them. Sometimes a print which has been made from a masked negative so as to show a wide margin of paper has an imitation plate mark made around it by pressing into the paper a sheet of card or metal slightly larger than the print itself. In the case of a photograph such a mark has no real meaning or justification.

PLATE SHEATH (See "Sheath.")

PLATE SPEEDS (See "Sensitometry.")

PLATE TESTING (See "Sensitometry.")

PLATE VICE

A screw vice or clamp used at one time to hold the daguerreotype plate while buffing or polishing, and still sometimes employed when cleaning glass plates previous to coating with collodion in the wet-plate process, and for other purposes. It consists of a square wooden frame with a sliding block adjusted by a screw, usually of beechwood.

PLATE WHIRLER (See "Whirler.")

PLATES, VARIETIES OF (See separate headings; for example, "Albumen Process," "Collodion Process (Wet)," "Ferrottype Process," "Isochromatic Plates," etc.

PLATE-SUNK

A term used to describe a mount made with a depression in imitation of the indentation in the paper caused by the pressure of the metal plate in printing etchings and engravings. (See "Plate Mark.")

PLATINIC CHLORIDE (See "Platinum Perchloride.")

PLATINO-BROMIDE

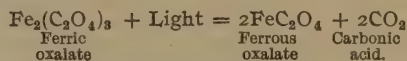
A grade of bromide paper with a matt surface giving an effect intended to resemble platino-type.

PLATINO-MATT

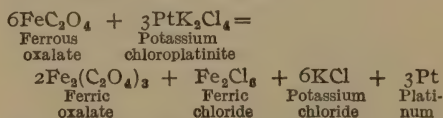
The term applied to the surface of some grades of bromide and gaslight papers which are made to give an effect in imitation of platino-type. (See also "Platinum Paper, Substitutes for.")

PLATINOTYPE PROCESS

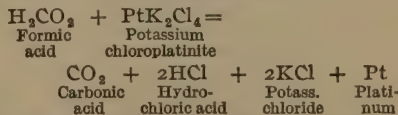
A printing process in which the image is partially printed out and then developed to its full strength, based on the light-sensitiveness of iron salts and not directly upon that of a platinum compound. The ferric salts are reduced by the action of light to the ferrous state, in which condition they partially reduce the platinum salt, the conversion to metallic platinum being completed by the ferrous salt in the "developer." The salt usually employed is ferric oxalate, the light action upon which is shown in the following equation:—



The action occurring during development may be represented by the following equation, which Berkeley (at one time manager of the Platino-type Company) gave in 1882:—



Hübl pointed out (1883) that whilst the above may be taken as the simplest form of equation and practically correct, formic acid probably is produced during exposure of the print to light, and that this acid plays a part in the development of the image, as follows:—



Although the process is based on the sensitiveness of the iron salts and not on that of the platinum compound, the latter certainly undergoes some little change, and assists the decomposition of the ferric salt, since a mixture of the two is undoubtedly more sensitive than the oxalate alone.

The first discovery of the action of light upon a platinum salt is said to have been by Gehlen, about 1804. But the first communication of any importance was by Sir John Herschel before

the Oxford meeting of the British Association, in 1832. Robert Hunt, in 1844, also experimented. The simple platinum process as it is now known is due to W. Willis, who patented it on June 5, 1873 (No. 2011), and who, in 1878, 1880, and 1887, took out further patents for improvements.

Few photographers care to attempt to make their own platinotype paper, as the materials are expensive and extreme care and cleanliness are necessary. However, all necessary instructions for doing so are here given. The late W. J. Warren advocated the following sensitising solution, which must not be acid:—

Potassium chloroplatinite solution (1 in 6) . . .	3 oz.	300 ccs.
Ferric oxalate solution (as below) . . .	2 $\frac{3}{4}$ "	275 "
Water . . .	$\frac{1}{2}$ "	50 "

The ferric oxalate solution consists of oxalic acid 1 part, ferric oxalate 15 parts, water 60 parts.

A strong paper is sized with 15 grs. of arrowroot, which is made into a cream with 1 oz. of water and poured gently into 30 oz. of boiling water, the whole being then boiled for eight minutes. The paper is immersed in the size for three minutes, dried, re-sized, dried again, laid on a sheet of glass, and the sensitising solution applied (in a yellow light) with a tuft of cotton-wool, preferably wrapped with fine silk. The paper is then dried at a temperature of 100° F. (38° C.), for which no variation is allowable, the drying taking only from two to four minutes.

Beanland recommends an arrowroot sizing of 30 grs. in 4 oz. of water, prepared and used as above, and the following sensitising formulæ, which, by a little modification, may be used in the preparation of "cold bath" papers for cold tones and "hot bath" paper for sepia tones:—

A. Potassium chloroplatinite . . .	60 grs.	15 g.
Distilled water . . .	360 mins.	84 ccs.
B. Ferric oxalate . . .	84 grs.	21 g.
Oxalic acid . . .	8 "	2 "
Distilled water . . .	720 mins.	168 ccs.

For cold bath paper mix A and B and add 60 mins. or 14 ccs. of water. For sepia paper mix A and B and add 60 mins. or 14 ccs. of a five per cent. solution of mercuric chloride. The addition of a few grains of potassium chlorate (one grain to the ounce is advised by Warren) will give increased contrasts to the print when either of the above formulæ is used. According to Beanland, 140 to 170 mins. are sufficient to coat a sheet of paper 26 in. by 20 in. The coating and drying are important as before.

The addition of a very small quantity of gold chloride to the sensitising solution is said to be of great advantage, the following sensitising mixture being recommended highly by some American workers:—

Ferric oxalate . . .	90 grs.	90 g.
Chloroplatinite solution (70 grs. per oz.) . . .	60 mins.	60 ccs.
Gold chloride solution (5 grs. per oz.) . . .	3 "	3 "
Potass. chlorate (saturated solution) . . .	2 "	2 "

Coat the sized paper with this and dry quickly. For thin negatives the quantity of gold may be slightly increased, but too much gold will spoil the bath and precipitate the platinum. The paper is developed on a cold solution of potassium oxalate, but if a hot bath is preferred gold must be omitted.

The following qualities of ready sensitised papers are manufactured by the Platinotype Company:—

For the cold bath process: AA, smooth, medium thickness. KK, smooth thick paper, fine surface, gives bright prints. CC, rough-surfaced, thick and strong, suitable for large work. TT, rough, thick, gives greater contrast than CC. YY, very thick and smooth. ZZ, very thick and slightly rough. For the hot bath process: S, smooth, to give rich sepia colour. RS, rough-surfaced for sepia, same substance as CC. The qualities TT, YY, and ZZ can also be coated for sepia. In addition there is a platinotype paper having a hard and resisting surface with an ivory-like sheen, of a brilliant black or sepia, and of a warmer tone than that afforded by the matt papers. These papers are supplied in air-tight tins, each containing a piece of calcium chloride to absorb any moisture. The paper should be stored in the original tin with the calcium, or transferred to a calcium tube. It is a good plan to place a wide rubber band round the joint between the lid and the tin box. The paper needs careful handling as the sensitive surface when dry is liable to crack; usually the sensitive surface is easily distinguished by its yellow colour, and is rolled outwards. Some workers keep platinotype paper a long time and in a damp condition in order to get certain effects, but technically perfect prints can only be obtained upon paper kept perfectly dry. Should paper become damp it may be dried in a warm oven or by keeping it in a calcium tube.

Platinotype paper is printed in daylight under a negative; the latter may with advantage be warmed, and a piece of vulcanised rubber (also warmed) placed between the paper and the back of the frame. A clear and brilliant negative, free from fog, gives the best results; flat negatives should be avoided.

The depth to which printing needs to be carried can be ascertained only by experience. The paper is more rapid than P.O.P., and prints in approximately about one-third the time. When the paper is sufficiently printed the image will be very faint and of a pale orange or a delicate purple colour on a yellow ground. Owing to this faintness there is a tendency to over-print and over-develop. The rule is to print until all the details can be seen except those in the highest lights, and this applies to both the "cold bath" and "hot bath" papers. After printing and before development the prints should be kept bone dry, as otherwise they will lack vigour, and the purity of the whites may be impaired. The paper should never be roughly torn, as there is a risk of the particles of platinum falling on the paper and causing black spots upon the print.

Cold Bath Process.—This gives black-and-white prints. Development should be conducted in a feeble white light or by gaslight, to avoid

any degradation of the whites. The paper makers' special developer, or an ordinary potassium oxalate developer, may be used. The special salts supplied by the makers are known as "D" salts; the contents of one tube ($\frac{1}{2}$ lb.) are dissolved in 48 oz. of water, which forms a stock solution. One part of this is mixed with 1 part of water, which then acts as a developer. A popular developer is—

Potassium oxalate	. 3 oz.	330 g.
Hot water	. 10 "	1,000 ccs.

For use, mix 1 part with 2 parts of water. The addition of 1 part of a saturated solution of oxalic acid to 20 parts of mixed developer tends to give warmer tones. Use the best neutral potassium oxalate, because if alkaline the blacks will not be good. Another good developer is—

Potassium oxalate	. 1 oz.	110 g.
Potassium phosphate	. $\frac{1}{4}$ "	28 "
Hot water	. 10 "	1,000 ccs.

When cold it is ready for use. Although the process is known as the "cold bath," the developer may be used warm if desired, and in no case must the temperature be lower than 60° F. (15.5° C.). By raising the temperature of the bath, even to 100° F. (about 38° C.), under-exposed prints may often be saved.



A. Developing Platinotype Print

The correct way to develop a platinotype print is just to fill a flat dish with the developer, and to take the dry print by the ends and hold it face downwards near the surface of the solution as at A; then with one hand draw one end along the surface of the bath (see the arrow), bringing the opposite end on to the surface of the solution gently and evenly so that no air bells form between the two. After a few seconds' treatment turn over the print in order to see whether the solution is working properly. A correctly exposed print may take half a minute or more to develop. Although development may be arrested before all the ferrous oxalate is reduced by the potassium oxalate developer, generally it is found that when development is cut short the picture will not be entirely satisfactory. A scum is apt to form on the surface of the developer, and when this happens it should be skimmed off with a stiff piece of paper; if allowed to remain it may cause marks upon the print. The liquid should also be stirred or rocked between each development in order to break up any scum which may be left by a previous print.

A fully developed platinum print must be placed face downwards, and without washing,

into the following bath, which acts both as a clearer and fixer:—

Hydrochloric acid (pure,			
sp. gr., 1.16)	. 1 oz.	16 ccs.	
Water	. 60 "	1,000 "	

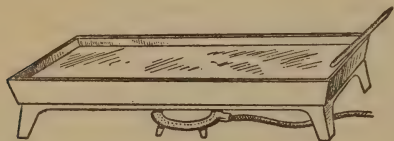
Citric acid (1 oz. per 20 oz. of water) may be used instead. The print remains in a portion of the acid solution for five minutes; the discoloured solution is then poured away and a second portion used, following in the same way with a third, so that the print is immersed in three acid baths for five, ten, and fifteen minutes respectively. The acid bath before use should be perfectly clear, but the effect of introducing a print is to turn it yellow, which fact affords a method of testing whether the print is sufficiently cleared or not. Until the print ceases to give a tint to the acid bath it is safe to conclude that it is not sufficiently cleared. So long as yellowness can be seen, traces of iron (which it is the function of the acid to remove) remain in the paper, and the treatment must be continued.

The print is next washed in four or five changes of water to clear away the acid, and the print dried between clean white blotting-paper. Common soda is sometimes added to the washing water to neutralise the acid, but with proper washing it should be unnecessary.

Sepia Prints by Cold Development.—Baron Von Hübl gives the following particulars for producing a special paper and for working it: "Take 1 gr. of yellow oxide of mercury and 5 grs. of citric acid, add 20 ccs. of water, and dissolve by heat. Filter the colourless fluid. This is kept as a stock solution for addition to the sensitising bath. The paper should be prepared with arrowroot and sensitised with 8 ccs. of normal iron solution, 4 ccs. of platinum solution (1 in 6), 1 to 4 ccs. of citrate of mercury solution. The addition of a little citrate or oxalate of ammonium will keep the high lights pure, and the gradation may be modified by adding sodium chloroplatinite, or bichromate of potash. The paper should be sensitised in the usual manner. The developer should be strongly acidulated with oxalic acid, and the strength of the solution of oxalate of potash may vary between 12½ to 25 per cent. The formula may be stated as follows: Water, 1,000 ccs.; neutral oxalate of potash, 120 to 250 grs.; oxalic acid, 10 grs. The development may take place in a dish in the ordinary way, or a brush may be used. The prints must, however, be at least five minutes in contact with the developer to effect complete reduction, otherwise they will lose considerably in the fixing bath, which should be a 1 per cent. solution of hydrochloric acid. Leave the prints for half an hour in the fixing bath, and then wash thoroughly. The colour and gradation of the image may be modified considerably by the composition of the sensitising solution, the developer, and the peculiarities of the paper used." In Baron Von Hübl's work, "Der Platin-druck," the normal iron solution is given as composed of 20 per cent. of ferric oxalate, to each 100 ccs. of which 1 to 2 grs. of crystallised oxalic acid are added.

The Hot Bath Process.—The paper used for the hot bath process gives sepia prints. The paper is sold, stored and printed in the same

way as cold bath paper. The sepia paper is a trifle more sensitive than the black paper, and more easily affected by faint light. The Platinotype Company's "D" salts may be used for developing, in which case the half-pound is dissolved in 32 oz. of water. The stock solution of potassium oxalate is the same as that first given, but for use 10 parts are mixed with 1 part of a saturated solution of oxalic acid; this mixture should be thrown away after use, as it soon loses quality. The solution, in use, should be maintained at a temperature of from 160° F. to 170° F. (71° C. to 77° C.), although good results are obtainable with a cooler bath; the solution can be heated in a porcelain dish, or, more safely, in an enamelled iron vessel supported over a spirit lamp or gas ring (B). A triplate, asbestos sheet, or sand bath should be interposed between the flame and a porcelain dish in order to prevent cracking. The developing and clearing (fixing) are precisely the same as for cold bath paper. Owing to the temperature of the bath some evaporation takes place and it becomes necessary to add from time to time sufficient water or more solution to bring the liquid up to practically its



B. Heated Developing Dish

original bulk. A cracked enamel dish must not be used, as any exposed iron would cause the prints to be discoloured; the sepia developing bath after use must be kept in the dark and not used for cold bath (black) pictures. As the sepia prints, unlike the black ones, may be affected by light when in the acid bath, and in the developer, they must be manipulated in a very weak light. The black and sepia papers should not be kept together in the same tin, and neither should the two kinds of prints be cleared and fixed together in the same bath, as otherwise the purity of the blacks in the cold bath paper will suffer.

Red Prints by Development.—The *Photo Zeitung* published the following formulæ:—

A. Oxalate	potash		
(neutral)	.	1 oz.	120 g.
Water	.	4 oz.	154 mins. 480 ccs.
B. Copper chloride	.	32 grs.	8 g.
Water	.	2 oz.	77 mins. 240 ccs.
C. Mercuric chloride	.	120 grs.	30 g.
Water	.	2 oz.	77 mins. 240 ccs.
D. Lead acetate	.	8 grs.	2 g.
Water	.	1 oz.	38 mins. 120 ccs.

Take 12 parts of A and 4 parts of B, stir together, and add 4 parts of C and 1 part of D; heat until the precipitate is dissolved, filter, and use at a temperature of 185° F. (85° C.). Fix in dilute hydrochloric acid, follow by a weak bath of ammonia, and finally wash in water.

Development with Glycerine.—The addition of glycerine to a developer allows of considerable control and of local development. The print is laid flat and the shadow parts coated with

glycerine. Three vessels are filled as follows:—No. 1, with full strength developer; No. 2, with a developer weakened a little, together with an equal quantity of glycerine; and No. 3, with a still weaker developer with glycerine. No. 1 is painted over the portions which are likely to be too light, and then the other parts are rapidly brushed over with the weaker solutions, using strong or weak developer afterwards to get the desired effect. Care should be taken to blend the parts together so as to prevent the occurrence of sharp dividing lines. Where backgrounds are very light it is possible to get effective vignettes simply by not working upon the edges with the developer. Some American workers have paid particular attention to this process, particularly Messrs. Stieglitz and Keiley, who give the following as their method of working:—Using the heavier grades of paper, printing should be carried further than for ordinary development, as far, in fact, as to record the half-tones in the high lights. When printed, the print is laid upon a sheet of glass, a little glycerine being smeared on the glass to keep the print flat and from slipping about. The face of the print is then evenly coated with pure glycerine, and blotting-paper is pressed down upon it; the print is then thinly re-coated and developed by means of brushes, two solutions being used, one (A) consisting of equal parts of normal developer and glycerine, and the other (B) pure developer. A is just used on those parts which it is thought desirable to bring up first; B is used where a pronounced shade is required. When development has been carried far enough, the print is blotted at that place, which should be re-covered with glycerine and not again touched. To introduce warm tones and so produce a print in two colours, three additional solutions are required:—(1) A strong solution of mercuric chloride; (2) ordinary developer plus the mercury solution, and (3) glycerine developer plus the mercury solution. The print is treated at one place with mercurised developer and at another with ordinary developer. The mercury tone is more transparent than the ordinary black tone so that development may be carried farther. The work must be carried out in a subdued light, as otherwise the high lights will be discoloured. When development is complete, the prints should be cleared in the ordinary hydrochloric acid bath and washed.

Intensifying and Reducing.—The following method, invented by Hübl in 1895, will give vigour to an under-exposed and pale black print. Make up:—

A. Sodium formate	.	48 grs.	11 g.
Distilled water	.	1 oz.	100 ccs.
B. Platinum per-			
chloride	.	10 grs.	2'3 g.
Distilled water	.	1 oz.	100 ccs.

Add about 15 drops of each to 1 oz. of water, immerse the weak print therein, rock the dish until the picture is dark enough, and then wash and dry. Some processes of intensifying weak platinum prints alter the tone. One worker has advocated an acid mixture of gallic acid and silver nitrate, another an acid hydroquinone and silver intensifier, and another a ferrous oxalate developer to which a few drops of a

chloroplatinite solution have been added. Some of the toning processes (Dolland's, for example, *which see*) intensify as well.

To reduce over-printed platinotype prints, immerse them in a saturated solution of chloride of lime, and when sufficiently reduced transfer them to a 5 per cent. solution of sodium sulphite to stop the action of the lime, then wash and dry. This reducer causes the paper to deteriorate and is recommended only in extreme cases.

Toning.—There are many processes for toning black platinotype prints to other colours. Both the Packham and Dolland processes are good (*see* under the headings "Catechu Toning" and "Dolland's Process"), the former giving brown tones and the latter rich black ones. Uranium is widely used for brown, red, and blue tones, but does not give very permanent results. An excellent formula is that advocated by Hübl:

A. Uranium nitrate . . .	96 grs.	28 g.
Glacial acetic acid . . .	96 "	28 "
Water	2 oz.	250 ccs.
B. Potass. ferricyanide . . .	96 grs.	28 g.
Water	2 oz.	250 ccs.
C. Ammonium sulpho- cyanide	1 oz.	138 g.
Water	2 "	250 ccs.

For brown and red tones, add 5 drops of each to 1 oz. of water. Thoroughly clear and wash the prints, place in the toner, and allow to remain until they are of the colour desired; they go from black to brown, and then to a red. The process slightly intensifies the print, the darkest portions gaining more in proportion than the light ones. For blue tones the A bath is not wanted, the following being used instead:—

D. Ammonia-iron-alum . . .	96 grs.	28 g.
Hydrochloric acid . . .	96 mins.	25 ccs.
Water	2 oz.	250 "

Add 12 drops of D to 5 oz. of water, then add successively 5 drops of B and 12 drops of C. Immerse the print therein and rock the bath until of the desired tone. The dish must be thoroughly cleaned before using for brown tones.

Stale Platinum Paper.—When stale paper must be used, potassium bichromate may be added to the oxalate developer, but a more satisfactory salt is the neutral potassium chromate, $\frac{1}{2}$ gr. of which should be added to 1 oz. of the ordinary developer diluted with one-third water. Paper five years old has been known to give good bright prints by this treatment. $\frac{1}{4}$ gr. per ounce has been known to give good results on paper two years old.

PLATINOUS CHLORIDE (*See* "Platinum Bichloride.")

PLATINOUS POTASSIUM CHLORIDE (*See* "Potassium Chloroplatinite.")

PLATINUM (Fr., *Platine*; Ger., *Platin*)

Pt. Atomic weight, 193.4. A white heavy metal found native in the state of impure ores. It is very infusible and practically unaffected by the atmosphere or most acids, but readily soluble in aqua regia. When deposited in a finely divided state it is an intense black and forms the image in the platinotype process.

PLATINUM BICHLORIDE (Fr., *Bichlorure de platine*; Ger., *Platindichlorid*)

Synonyms, platinous chloride, platinum dichloride, platinochloride. PtCl_2 . Molecular weight, 264.4. Solubilities, insoluble in water, soluble in hot hydrochloric acid. A greyish green or brown powder obtained by reducing platinum perchloride by heat or sulphurous acid. It is not used in photography, but it is used to prepare potassium chloroplatinite.

A solution of this salt in hydrochloric acid yields chloroplatinous acid H_2PtCl_4 or $\text{PtCl}_2 \cdot 2\text{HCl}$.

PLATINUM PAPER, SUBSTITUTES FOR

Many attempts have been made to produce on bromide and other papers effects similar to those given by platinotype. A number of the platino-matt papers may be made to produce platinum-like prints, but the two can always be distinguished by applying a drop of a solution of mercuric chloride as used for intensifying. The solution bleaches the part of the bromide print to which it is applied, but has no effect upon a platinum print.

Special papers have been made for yielding prints resembling platinum, and of the home-made kinds, that prepared according to the formula worked out by Dr. Vollenbach, and published in the *Deutsche Photo. Zeitung*, is considered one of the best. It is said to yield rich deep platinum-like blacks even from weak negatives. Paper is immersed for three or four minutes in:—

Gelatine	22 grs.	5 g.
Citric acid	13 "	3 "
Chrome alum (sol. 1:20) . . .	220 mins.	50 ccs.
Aluminium chloride (10% sol.)	44 "	10 "
Distilled water	10 oz.	1,000 "

After immersion hang up to dry. It is sensitised (in yellow light) with:—

A. Gelatine	2.2 grs.	$\frac{1}{2}$ g.
Salicylic acid	4 "	1-10 "
Distilled water	1 oz.	100 ccs.
B. Green ammonia citrate of iron	38 grs.	20 g.
Distilled water	1 oz.	100 ccs.
C. Silver nitrate	55 grs.	12.5 g.
Distilled water	1 oz.	100 ccs.
D. Uranium nitrate	38 grs.	20 g.
Distilled water	1 oz.	100 ccs.

By using more of C, softer prints are produced; more of B gives hard prints; less of D gives browner tones; and more of D gives blue-black tones. For greyish-black resembling platinotype, use 1 part of A and B and 2 parts of C and D. Mix in the order above given, or else a precipitate is formed and a muddy solution results. Pour the solution on the paper, pinned to a board, in a little pool and then distribute with a wad of cotton-wool; finally dry quickly but evenly. Expose the same as with platinum paper until detail is faintly visible, and develop with—

Ferrous sulphate	188 grs.	43 g.
Acetic acid	67 mins.	14 ccs.
Distilled water	10 oz.	1,000 "

When sufficiently developed, place the print in a

1 per cent. solution of nitric acid for three minutes and then fix in—

Sodium hyposulphite	785 grs.	180 g.
Sodium sulphite (cryst.)	110 "	25 "
Sulphuric acid . . .	14 mins.	3 ccs.
Water	10 oz.	1,000 "

The prints are apt to reduce slightly in the fixing bath.

PLATINUM PERCHLORIDE (Fr., *Chlorure de platine*; Ger., *Platinchlorid*)

Synonyms, platinic chloride, platinum tetrachloride, chloroplatinic acid, muriate of platina.

$\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$ or $\text{PtCl}_4 \cdot 2\text{HCl} \cdot 6\text{H}_2\text{O}$. Molecular weight, 516.4. Solubilities, 1 in 1 water, soluble in alcohol and ether. A dark brown mass or red crystals obtained by dissolving platinum in aqua regia and evaporating. It is chiefly used as the starting point for the manufacture of potassium chloroplatinite, but is also occasionally used for toning.

PLATINUM TETRACHLORIDE (See "Platinum Perchloride.")

PLATINUM TONING

The theory of platinum toning is the same as that of gold toning, explained under that heading, except, of course, that platinum is substituted for gold. The earliest form of bath consisted of 1 gr. of platinic chloride in 15 oz. of water, and it was not until the introduction of the platinotype printing process, when potassium chloroplatinite was made available, that platinum toning became almost if not quite as popular as gold for silver prints, particularly those upon matt papers. As with gold, almost any tone may be obtained.

Print-out Silver Papers.—Two stock solutions are necessary:—

A. Common salt . . .	$\frac{1}{2}$ oz.	55 g.
Alum	$\frac{1}{2}$ "	55 "
Water	10 "	1,000 ccs.

This may be made up with hot water, and is ready for use when cold.

B. Potassium chloroplatinite . . .	40 grs.	9 g.
Water	10 oz.	1,000 ccs.

The chloroplatinite is sold in sealed glass tubes containing 15 grs. Soak off the label, place the unbroken tube in the bottle or measure with the water, and break the tube while in the water. Each quarter ounce (120 drops) of the solution will contain 1 gr. of the chloroplatinite; the mixture should be kept in the dark. Tones may be varied from red-brown to warm black by using a mixture of from 10 to 160 drops of B, 1 oz. of A, and 10 oz. of water, this quantity being sufficient for ten half-plate prints or their equivalent. The prints dry of a darker tone than they appear when wet; and therefore toning should be stopped just before the desired tone is reached, judging the tone by looking through the prints. Toning invariably continues in a slight degree during the washing previous to fixing, unless a "stop bath" be used, such a bath consisting of 100 grs. of sodium carbonate crystals in 10 oz. of water.

After toning, prints are washed and fixed as usual.

Alternative Baths for Silver Prints.—Some alternative baths will now be given.

Cowan's Bath

Common salt . . .	10 grs.	2.3 g.
Potass. chloroplatinite . . .	1 "	.23 "
Chrome alum (1% sol.) . . .	10 oz.	1,000 ccs.

Phosphoric Bath

Potass. chloroplatinite . . .	4 grs.	2 g.
Phosphoric acid (sp. gr., 1.120)	1 drm.	28 ccs.
Distilled water	4 $\frac{1}{2}$ oz.	1,000 "

The phosphoric acid is the "acidum phosphoricum dilutum" of the British Pharmacopoeia. Wash and fix as usual. (Many other acids can be used in this way.) Prof. Namias states that the phosphoric acid may be advantageously replaced by oxalic acid.

Platinum may be used in the combined toning and fixing form. A good formula is:—

Sodium hyposulphite . . .	1 oz.	110 g.
Lead nitrate	60 grs.	14 "
Alum	60 "	14 "
Sodium formate	20 "	4.6 "
Formic acid	$\frac{1}{2}$ drm.	6 ccs.
Platinum bichloride . . .	2 grs.	.5 g.
Hot water	10 oz.	1,000 ccs.

Dissolve the lead and sodium formate in a small quantity of the water, then the "hypo" and the other ingredients (except platinum) in the remainder. Mix together, allow to stand in an uncorked bottle for 24 hours, and then add the platinum bichloride. The prints (P.O.P.) should be passed through a weak salt and water bath before toning.

A formula for the "Haddon" platinum toning bath is given in an article under that name. For platinum and gold baths (combined) see under "Gold and Platinum Bath."

Bromide Papers.—Most of the above baths may be used for bromide papers, and the following is recommended:—

Hydrochloric acid . . .	50 mins.	1 ccs.
Potass. chloroplatinite . . .	5 grs.	1 g.
Distilled water	10 oz.	1,000 ccs.

Toning for about twenty minutes should give a good black image. Wash, fix in "hypo," and wash again thoroughly.

C. W. Somerville's toner (1902) is as follows:—

Potass. chloroplatinite . . .	20 grs.	4.6 g.
Mercuric chloride	10 "	2.3 "
Citric acid	90 "	200 "
Distilled water	10 oz.	1,000 ccs.

1 oz. of this will tone three or four half-plate prints in about twenty minutes; the print is previously fixed and washed, and after toning, again fixed and washed. If the sepia toned print is immediately subjected to an ordinary developer as used for bromide paper, the black colour will return with great intensification, but washing will prevent this.

Lantern Slides.—Lantern slides of the gelatine variety may be toned by any of the above processes, but the most widely used bath is—

Hydrochloric acid	. 1 min.	2 cc.
Platinum chloride	. 1 gr.	2 g.
Water	. 10 oz.	1,000 ccs.

This tones rapidly, but reduces slightly.

PLATYSTIGMAT LENS

An anastigmatic lens introduced by Wray, and consisting of two nearly symmetrical cemented triple combinations. It has an initial intensity of $f/7.3$ and an extreme angle of 90° . The back lens may be used alone, and has a focal length about double that of the complete combination.

PLAYERTYPE

A process for the direct copying of engravings, invented by J. Hort Player in 1896. The engraving (line drawing) to be copied is laid face downwards upon a perfectly flat surface, the sensitive (bromide) paper is laid film side downwards upon it, and a sheet of glass placed over all. A yellowish light is then held over the glass, the exposure being made through the glass and the sensitive paper. From three to ten minutes may be necessary in yellow light according to the sensitiveness of the paper; with white light the exposure is much shorter. The developer recommended for this work is:—

Hydroquinone	. 30 grs.	7 g.
Sodium sulphite	. 120 "	28 "
Sodium carbonate	. 240 "	56 "
Water	. 10 oz.	1,000 ccs.

Development is continued until the image appears to be buried. Having obtained a negative in this way, prints may be obtained from it by contact printing. The method has the advantage of giving a direct copy (a paper negative) of the same size as the original, and, of course, without using a camera. The clearer and more contrasty the original drawing or engraving the better will be the copy on the bromide paper, but should the latter be faulty, it may be intensified, reduced or cleared. The process was modified somewhat in 1900, when a sheet of green glass was laid over the paper and the exposure, of from five to ten minutes, made through that.

PLUMB INDICATOR (Fr., *Plomb photographique*; Ger., *Photographische Bleiwage*)

An appliance fitted to stand cameras to enable the back to be rendered truly vertical. The



Two Patterns of Plumb Indicator

pattern shown at A consists of a swinging pendulum or pointer attached to a brass plate,

which is screwed to the side of the camera with its edge parallel to the back. The bottom of the pendulum will then point to a notch on the plate when the back is vertical. Pattern B has a pivoted needle weighted at the lower end, and attached to the side of the camera as before described; the point of the needle indicates on a scale whether or not the back is upright.

PLUMBAGO

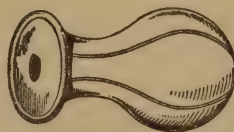
A synonym for blacklead.

PLUMBAGO PROCESS

The "dusting-on" process, with plumbago (blacklead or graphite) used as the powder. Employed in the ceramic process and for making duplicate negatives. Wood engravers sometimes make use of it as a means of obtaining prints on wood.

PNEUMATIC HOLDER (Fr., *Ventouse pneumatique*; Ger., *Pneumatischer Plattenhalter*)

A rubber bulb with a flat disc at one end, as illustrated. It is used to hold plates by "suction" when coating with collodion, varnishing, etc. The bulb is pressed to expel the air and the disc is held against the plate, to which, on



Pneumatic Holder

releasing the pressure on the bulb, it immediately clings, enabling the latter to be lifted as if by a handle and supported in any required position. Those of red rubber are best. It is advisable to immerse the holder in lukewarm water before using, or the part of the plate directly over the bulb may be chilled, and uneven coating result.

PNEUMATIC RELEASE (Fr., *Poire pneumatique*; Ger., *Pneumatische Birne*)

A rubber ball with tube connection, by means of which the camera shutter can be operated without the necessity of touching it, or, if needful, worked from a convenient distance by having a sufficient length of tubing. Many diaphragm shutters have a metal tube at one side, in which a piston connected to the mechanism slides up and down. The free end of the rubber tubing is stretched over this metal tube, when pressure on the ball at the other end compresses the air, pushes up the piston, and releases the shutter. Roller-blind shutters usually work on a different principle; these have at the end of the tubing a small rubber bulb, which is adjusted beneath the catch that retains the wheel regulating the spring blind. In this case pressure on the ball inflates the bulb, which pushes up the catch and releases the wheel. Studio pneumatic shutters mostly have a tap next to the ball; this, if turned after pressing the latter, prevents the return of the compressed air, so that the shutter remains open

for focusing, etc., until the tap is turned in the contrary direction.

POCKET CAMERA (Fr., *Chambre de poche*; Ger., *Taschenkamera*)

Very small hand cameras are now made, some of them capable even of going in a waist-coat pocket. When well-made and fitted with a first-class lens they are apt to be expensive, as the mechanism and adjustments call for great neatness and accuracy. The shutters are usually marvels of compactness and ingenious design. With the short-focus lenses used, great depth of definition is attainable, and the small negatives will bear any reasonable degree of enlargement. Such cameras call for considerate handling. If one is constantly carried, it is well to have a small leather bag to protect it from dust and grit.

POISONS AND THEIR ANTIDOTES

The table given below is due to J. V. Elsdén, and is reprinted from the *Brit. Journ. Phot. Almanac*. Dr. R. J. Hillier, in commenting upon Elsdén's table, which he regards as reliable and accurate, recommends that in all cases of poisoning a doctor should first be sent for, and in the meantime an antidote given, and vomiting induced by tickling the throat or by drinking strong mustard and water or lukewarm water. Acids are antidotes for alkalis and vice versa, but there is danger in giving strong acids and alkalis as antidotes, and unprofessional treatment should seldom go beyond some such

emetic as mustard and water. Except where strong acids and alkalis have been taken, 25 grs. of zinc sulphate forms a good emetic. If a highly irritant poison, such as a strong acid (not pyrogallic) or alkali, or potassium cyanide, has been swallowed, the only hope of saving life is the prompt application of the antidote.

POISONS, SALE OF

The following statement is due to E. J. Wall, and is reprinted from the *Photographic Dealer*. According to the Pharmacy Act, 1868, it is illegal for any person not being a duly registered pharmaceutical chemist or chemist and druggist, to sell certain chemicals and substances, which are included in a schedule, this being divided into two parts. In the first part are included those substances which can only be sold when the purchaser is known to the seller, or is introduced by some person known to the seller, who must enter the date of sale, name and address of purchaser, name and quantity of article, purpose for which it is required, which must be attested by the purchaser's signature; and the parcel or vessel must be labelled with the name of article, the word "Poison," and the name and address of the seller. For those articles included in Part 2 of the schedule only the three last requirements have to be fulfilled. There are really very few photographic chemicals included in the schedule, and not any that are used in considerable quantities. Corrosive sublimate, mercuric perchloride or mercuric chloride, is included in

THE CHIEF PHOTOGRAPHIC POISONS AND THEIR ANTIDOTES

	Poisons	Remarks	Characteristic Symptoms	Antidote
Vegetable Cautious Acid. Alkalis.	OXALIC ACID, including POTASSIUM OXALATE	1 dram is the smallest fatal dose known.	Hot burning sensation in throat and stomach; vomiting, cramps, and numbness.	Chalk, whiting, or magnesia suspended in water. Plaster or mortar can be used in emergency.
	AMMONIA	Vapour of ammonia may cause inflammation of the lungs.	Swelling of tongue, mouth, and fauces; often followed by stricture of the oesophagus.	Vinegar and water.
	POTASH			
	SODA			
	MERCURIC CHLORIDE	3 grains the smallest known fatal dose.	Acrid, metallic taste, constriction and burning in throat and stomach, followed by nausea and vomiting.	White and yolk of raw eggs with milk. In emergency, flour paste or "hypo" solution may be used.
Metallic Salts.	LEAD ACETATE	The sub-acetate is still more poisonous.	Constriction in the throat and at pit of stomach; crampy pains and stiffness of abdomen; blue line round the gums.	Sulphates of soda or magnesia. Emetic of sulphate of zinc.
	POTASSIUM CYANIDE	a. Taken internally, 3 grs. fatal. b. Applied to wounds and abrasures of the skin.	Insensibility, slow gasping respiration, dilated pupils, and spasmodic closure of the jaws. Smarting sensation.	No certain remedy; cold affusion over the head and neck most efficacious.
	POTASSIUM BICHROMATE	a. Taken internally. b. Applied to slight abrasions of the skin.	Irritant pain in stomach and vomiting. Produces troublesome sores and ulcers. Powerful irritant.	Sulphate of iron should be applied immediately. Emetics and magnesia, or chalk.
	SILVER NITRATE			
Concentrated Mineral Acids.	NITRIC ACID	2 drams have been fatal. Inhalation of the fumes has also been fatal.	Corrosion of windpipe and violent inflammation.	Common salt to be given immediately, followed by emetics.
	HYDROCHLORIC ACID	1 ounce has been fatal.		Bicarbonate of soda, or carbonate of magnesia or chalk, plaster of the apartment beaten up in water.
	SULPHURIC ACID	1 dram has been fatal.		
	IODINE	Variable in its action; 3 grains have been fatal.	Acrid taste, tightness about the throat, vomiting.	Vomiting should be encouraged, and gruel, arrowroot, and starch given freely.
	ETHER	Poisonous when inhaled.	Effects similar to chloroform.	Cold affusion and artificial respiration.
	PYROGALLOL	2 grains sufficient to kill a dog.	Resembles phosphorus poisoning.	No certain remedy. Speedy emetic desirable.

ACETIC ACID, concentrated, has as powerful an effect as the mineral acids.

PART 1. "Cyanide of potassium and all metallic cyanides and their preparations" is another item in Part 1. It is an open question whether this term may not be strictly held to include the ferri-, ferro-, and sulpho-cyanides; as a matter of fact, however, it is held that these preparations are not to be classed as *scheduled* poisons. Part 2 includes preparations of mercuric chloride; therefore any intensifier containing this cannot be sold except by a registered chemist. It also includes oxalic acid, which is but rarely used, and mercuric iodide and sulphocyanide.

Under the Poisons and Pharmacy Bill, 1908, Section 5 states, "It shall not be lawful to sell any poison to which this section applies by retail, unless the box, bottle, vessel, wrapper or cover in which the poison is contained is distinctly labelled with the name of the substance and the word 'Poison,' and with the name and address of the seller of the poison." The poisons here enumerated are sulphuric, nitric, and hydrochloric acids, and the soluble salts of oxalic acid. Presumably this would include even the dilute acids, although no differentiation as to strength is made. "Soluble salts of oxalic acid" naturally includes neutral potassium oxalate, and the oxalates of ammonium, sodium, and iron, also presumably potassium ferric oxalate and all preparations in which these may be contained. It will be seen that really there are very few scheduled poisons used in photography, but it must not be forgotten that there are many chemicals which are poisonous beyond these, and it would be as well to label as "Poison" all ferro-, ferri-, and sulpho-cyanides, bichromates, pyro, and all preparations of copper, uranium and cerium. If this is thought too drastic, then at least a warning label should be devised, somewhat on the following lines, "Care should be exercised in the use and storing of this chemical, as when taken internally it is poisonous." There is no difficulty in a firm of dry plate makers, etc., selling a poison to a wholesale house so long as it is marked "Poison." The Act only applies to sale to the public.

POITEVIN, ALPHONSE LOUIS

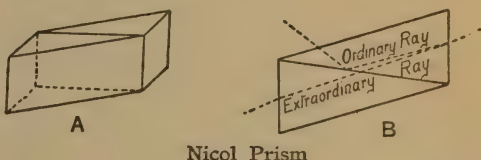
Born at Conflans, France, 1819; died at the same place 1882. He was a chemist and engineer, and took up the study of photography immediately after Daguerre's discovery was made known. He secured an award for a method of photo-chemical engraving upon plates coated with silver and gold. In 1855 he patented a "helio-plastic" process, by which films of bichromated gelatine were exposed to light under a negative and then soaked in water; parts of the picture were then in relief and a mould was taken. In the same year he discovered that bichromated gelatine which had been exposed to light would allow greasy ink to adhere to it, although it repelled water. Upon these facts he in 1856 based a photo-lithographic process, and he is looked upon as the practical founder of the carbon process, photo-lithography and collotype printing. In 1867 he was awarded the greater part of a prize of 10,000 francs for the discovery of permanent photographic printing processes.

POLARISATION

The splitting up or division of a ray of light into two distinct refracted parts.

POLARISCOPE (Fr., *Polariscope*; Ger., *Polariskop*)

When a ray of light falls on a crystal of Iceland spar in a direction not parallel with the principal axis, it is doubly refracted and split into two parts. One part, known as the ordinary ray, obeys the usual laws of refraction; the other, known as the extraordinary ray, behaves in quite a different manner. For examining the phenomena of polarised light a polariscope is employed; this usually consists of two Nicol prisms mounted in separate tubes, the lower



one being known as the polariser and the upper as the analyser. A Nicol prism is a rhomb of Iceland spar cut along the long diagonal, as shown at A, the two halves being then cemented together with Canada balsam. The ordinary ray has a higher refractive index than the balsam and is accordingly got rid of by total reflection, as at B, while the extraordinary ray passes through without interruption. If the analyser is rotated above the polariser the field is gradually darkened, and when the two planes are at right angles the light is extinguished. The polariscope is frequently used with the microscope. (See also "Nicol Prism.")

POLARISED LIGHT

Light rays that have been doubly refracted or split up.

POLARISER

A Nicol prism mounted in a tube, as described under the heading "Polariscope."

POLYCHROME, POLYCHROMATIC, AND POLYCHROMOTYPE

Terms applied to photographs and photographic reproductions in several colours.

POLYPOSE PORTRAIT

A portrait in which the sitter appears in two or more different positions. (See "Doubles" and "Multiple Photography.")

POLYSCOPE (Fr., *Polyscope*; Ger., *Polyskop*)

An apparatus patented by Robert H. Baskett. A suitable box contains two surface-silvered mirrors, with provision for adjusting these to any angle, which must, however, be capable of dividing into 360° without remainder. On placing a suitable object, such as a piece of lace, filagree work, floral decoration, or, in fact, almost anything of pleasing outlines, at the end of the box, the pattern is repeated symmetrically as in the kaleidoscope. If the subject

is then suitably lighted and a camera placed with its lens pointing into the box at the junction of the mirrors the ornamental arrangement may be photographed. Such patterns are of great assistance in making commercial designs.

PONTON, MUNGO

Born at Balgreen, 1802; died at Clifton, 1880. He was the first to observe the effects of the sun's rays on potassium bichromate, and on May 29, 1839, he communicated to the Society of Arts for Scotland "a cheap and simple method of preparing paper for photographic drawing in which the use of any salt of silver is dispensed with." His process was to spread a solution of potassium bichromate upon paper and expose it with a suitable object laid upon it to the sun's rays; the light acted upon and hardened certain parts, while those which were not acted upon could be dissolved away, leaving the object white upon a yellowish brown ground. He obtained copies of drawings and images of dried flowers in this way, and fixed them simply by washing in water. In 1849 he published a method of registering the hourly variations of the thermometer by means of photography.

P.O.P.

Printing-out paper. Generally understood to mean gelatino-chloride paper, used for all-round work. The initials were first used by the Ilford Company in 1891.

P.O.P. GASLIGHT PAPER

Ordinary P.O.P. can be made into gaslight paper by a process of converting the soluble silver salts into silver bromide, or into a mixture of silver haloids with a predominance of bromide. The P.O.P. should be immersed in the following solution for five minutes in the dark-room or in a very weak light and then washed and dried in the dark:—

Potassium bromide	. 36 grs.	3.3 g.
Potassium iodide	. 12 "	1.1 "
Copper sulphate	. 1 gr.	.1 "
Water	. 25 oz.	1,000 ccs.

A 5 per cent. solution of potassium bromide may be used with some papers instead of the above. After drying, the paper may be treated as gaslight paper.

PORCELAIN CLAY (See "Kaolin.")

PORCELAIN DISHES (See "Baths.")

PORCELAIN, PHOTOGRAPHS ON

The usual method of producing photographs upon porcelain is by the carbon transfer process. They may also be produced by the photo-ceramic and blue-print processes, etc., when the porcelain can be coated and sensitised. Photographic opals are sometimes referred to as porcelain plates. (See also "Photo-lithophane.")

PORCELAINOGRAPHY

A name given in the early 'fifties to the art of printing photographs upon porcelain, opal, and similar substances.

POROTYPE (Fr., *Porotype*; Ger., *Porotypie*)

A Continental process of copying engravings, depending on the fact that the ink lines are practically impervious to a certain gas as compared with the paper. A paper coated with a chemical pigment that is bleached by the gas is pressed into contact with the engraving, and the back of the latter is subjected to the gaseous fumes, which are obstructed by the lines of the picture; these therefore remain pigmented in the copy, while the unprotected ground is bleached.

PORTA, GIAMBATTISTA DELLA

An eminent Italian naturalist; born 1543, died 1615. He is the reputed inventor of the camera obscura (1569), but he more probably only improved the instrument.

PORTRAIT LENSES

Almost any lens working at an aperture of $f/6$ or larger is suitable for portraiture provided that its focal length is not less than $1\frac{1}{4}$ times that of the longest side of the largest plate which it will have to cover. The name is, however, by common consent confined to the Petzval form, known as the "ordinary" portrait lens, and also to the Dallmeyer, or "patent," portrait lens. The principal features of this type of lens are great rapidity, some lenses having an intensity of $f/2$, and extremely good definition over a moderate angle. The field of a portrait lens is usually curved, and this may in some cases be regarded as an advantage, inasmuch as it allows the knees and feet of a sitting figure to be focused equally well with the head without reduction of aperture. The Dallmeyer type of portrait lens has a great advantage over the original Petzval, as it allows the focus to be softened and distributed over several planes by turning the back cell, and thus increasing the difference between the two glasses which compose the back combination. Starting with absolute sharpness, the definition may be softened by degrees until fuzziness ensues by simply rotating the back cell. The latest model of this lens has the back cell fixed, and the softness is obtained by rotating the entire lens tube. The front combination of most portrait lenses may be used alone, and if they are to be employed for portraiture it is advisable that they be left in their normal position—that is to say, with the convex side to the sitter. By so doing sharper definition over a limited, but sufficient, field is obtained, without serious reduction of aperture. Should it be desired to use the front lens for landscape work, it is desirable that the flat side should be turned to the view, and the diaphragm closed until the desired sharpness is obtained. Portrait lenses may be used for outdoor work, and latterly have been in demand for reflex cameras. Portrait lenses are liable to give "flare spot" when used out of doors with small apertures, but this tendency is minimised if the diaphragm is placed in front of the lens instead of in the ordinary position. In selecting a portrait lens care should be taken not to choose one of too short a focal length. If possible this should be about twice that of the trimmed print, say 8 in. for cartes, $11\frac{1}{2}$ in. for cabinets, and 20 in.

to 24 in. for panels. Besides the recognised portrait type, special portrait lenses are made on the Cooke model, and these have the "diffusion of focus" adjustment. Most enlarging objectives are of the Petzval portrait lens construction, and may be used in the camera with good results. Magic-lantern lenses are also of this type, but are usually corrected for the visual rays only, and will not give a sharp image on the photographic plate.

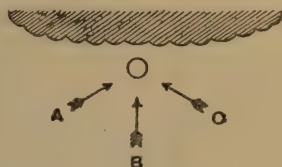
PORTRAITURE, COMPOSITE (See "Composite, Analytical, or 'Average' Portraits.")

PORTRAITURE

In all portraiture, the question of apparatus is not nearly so important as those of posing and lighting. The camera should preferably be of the stand variety, but hand cameras are also capable of producing good work; the ordinary fixed-focus pattern without magnifiers is not to be recommended for the work, as unless a very small stop is used the image will not be in focus, although such a camera answers for full-length portraits if the subject is sufficiently far enough away. Lenses that work at a fairly large aperture are the best for indoor portraiture. (See "Portrait Lenses.") The focal length of the lens is a matter of importance; the greater the focal length the more truthful is the result, as a rule; if a lens embracing a very wide angle is used, distortion is almost sure to occur, and the size of the nose, ears, hands, or feet will appear exaggerated. The question of isochromatic *versus* ordinary plates for portrait work need not be discussed here. Either may be used; but an isochromatic plate will do all an ordinary plate will do and a little more. More truthful rendering of colour is obtained by using a screen, but the exposure is thereby prolonged. Many professionals use isochromatic plates for certain subjects—such, for example, as very freckled faces, yellowish hair, coloured dresses, etc. A rapid plate is the most suitable for indoor work where the exposure is to be perhaps somewhat lengthy. Many of the plate makers give in their instructions special developers for portrait work, and photographers cannot do better than use them. They are compounded to give soft negatives, and are specially suitable for the plates with which they are issued. If no such special formula is given the usual developer will generally serve, but if the results are too hard the developer may be diluted with water so as to secure a softer result. Adurol, pyro-soda, and pyro-ammonia are very suitable. When "single solution" developers, patent concoctions or otherwise, are used, the safest way of securing a soft result is to develop until the image just appears, and then to transfer to a dish of clear cold water in which the image will go on developing slowly, giving it if required a moment or so in the developer occasionally and then transferring to the water. This method of developing brings out detail and gives softness in a remarkable manner. When the negative has sufficient detail and density it should be fixed in the usual manner.

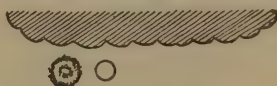
Outdoor Portraiture.—This is one of the commonest forms of photography and one in which failure frequently occurs. The old rule of

placing the sitter in the brightest light possible does not in these days of rapid lenses and plates give the best results as a rule. It is the too strong light that spoils many attempts at outdoor portraiture, and the more the light can be con-



A. Equal Lighting, causing Flatness

trolled, the better and more artistic are the portraits likely to be. Outdoor portraits frequently lack character, are flat, and devoid of any effects of light and shade which characterise professional studio work; and yet by working carefully one may easily obtain an effective portrait of a sitter. With two sitters this is more difficult, and it increases as the number of sitters grows. The usual defect in the outdoor portrait is flatness, caused by the light reaching the sitter from both sides and the top alike, as in A. Here it is supposed that the model is placed against a wall, hedge or other foliage to serve as a background, there being nothing on either side of or above the sitter to stop the immense flood of light, as represented by the arrows A, B and C. What is wanted is a trifle more light on one side of the face than the other, in order to obtain "roundness." It is sometimes difficult to get the required light and shade in the open, but a big tree is a useful accessory when utilised as shown at B. If the sitter is placed by the side of the trunk it may serve to cut off some of the side-light, while the boughs above will cut off superfluous top light. More portraits are perhaps taken in back yards or gardens than in the field; in such cases a dark folding screen, or even an open umbrella,

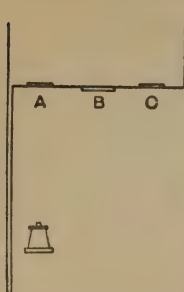


B. Side Light cut off by Tree

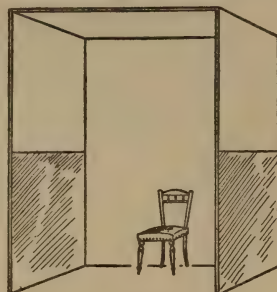
may be used with advantage to check the excessive light, but more often the trouble is overcome by arranging the positions of the camera and sitter. C represents the plan of part of a garden or back yard of the ordinary type. Against a

door is a favourite place to pose a model, say as at B, and success will depend upon the lighting, type of door or portico, etc. Doors may be made to serve admirably if the portrait is professedly an outdoor one and the figure three-quarter or

grounds serve very well, but in no case should they be so sharply focused as the subject. Ugly and unpromising backgrounds may very often be made to serve by placing the sitter well in front, using a large stop in the lens,

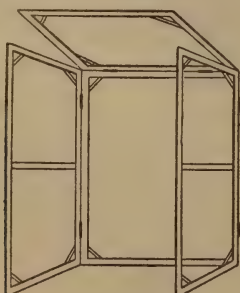


C. Portraiture at Back of House



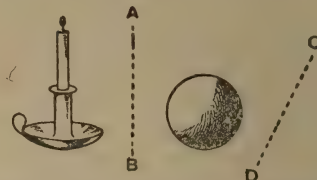
D. Portable Studio

full length. It is, however, almost hopeless to take a bust portrait with an artificial background placed as at B, because ordinarily there would be an equal amount of light on each side of the face. If a portrait head is to be taken and the effect aimed at is an artistically lighted studio effect, it would be better to place the sitter in the angle, as at A, and the camera parallel to the wall as shown. By so doing, the wall acts as a screen, and one side of the face is slightly in shadow. By allowing the camera to remain in the same position and placing the sitter at C, the result would even be flatter than at B, because the sitter is at a greater distance from the wall. In cases where the precise positions shown cannot be taken up, it is possible to carry out the same principles of lighting in other ways. The sitter could, for example, be placed in the angle A, and the camera parallel to the house at C, in which case the wall, possibly with foliage, would serve as a background, and the house itself as a screen for the light. There are many other obvious ways of securing more light on one side of the face than the other, which system of lighting will alone give the necessary roundness and lifelike appearance to portraits taken out of doors.



E. Frame for Portable Studio

Backgrounds are usually required for studies of heads, particularly when taken out of doors, as any bricks, foliage, etc., appearing behind the head are apt to distract the attention. For full and three-quarter figures, however, natural back-

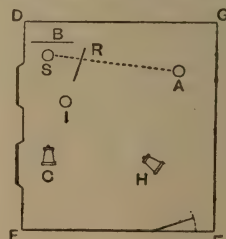


F. Side Light causing Harsh Lighting

and focusing the eyes of the model and not the background.

When much portrait work is to be done out of doors, as in the case of pageants, bazaars, fêtes, etc., it is advisable to make a kind of portable studio, as shown at D and E, a useful size for which is 8 ft. by 6 ft. Three frames are made of 3-in. by 1-in. wood, 8 ft. high and 6 ft. broad; one serves as the back and the two others are hinged thereon to serve as wings; a fourth frame is made to fold over the top, and is covered with white muslin, as are also the two top halves of the wings. The bottom halves are covered with dark material. Blinds are fitted over the white muslin at the side and top, in order that the amount of light reaching the interior may be regulated. Hooks or bolts keep the wings and top in position during use. A plain cloth background is then fitted to the back frame, or, if preferred, it may be left open and when in use pushed back against a suitable natural background.

A common defect in amateur portraits taken out of doors is the dark appearance of the sitters' faces, usually due to under-exposure, or to the use of a too brilliant background. When the sky is the background for a person's head, the face invariably comes out very dark, and halation often occurs. Models without hats are usually represented as having darker faces than those who wear large hats, because the latter act more or less as backgrounds and serve to isolate the face from the sky. An open umbrella or sunshade may occasionally be used to make the face appear clearer.

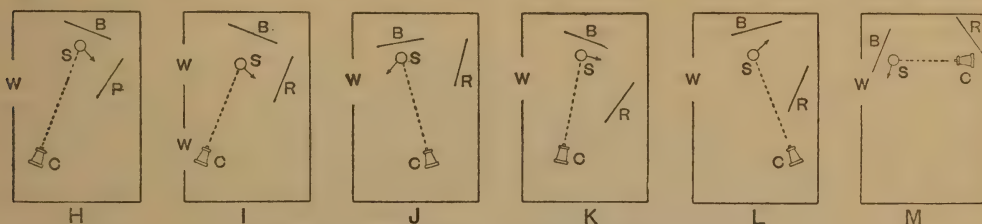


G. Room used as Studio

Indoor Portraiture.—Home portraiture indoors is a difficult branch of photography, because of the limited amount of light admitted by an ordinary window, and because what light there is comes from one point, which, in the absence

of precautions, gives harsh black-and-white effects. A simple experiment, and one which embodies all the principles of indoor lighting for portraits, is the following: In a darkened room place a lighted candle upon a table and

window is a large bay or French window, and the glass goes almost to the ground level. All sorts of lighting may be obtained in a home studio such as that described, as the sitter can be placed at any spot between S and A with



Six Kinds of Lighting Available in Room-studio

beside it an orange or a ball, as shown at F. The sphere is strongly lighted on one side only. If a sheet of tissue paper or muslin is held at A B, not only is the light softened on the candle side of the sphere, but it is also diffused, so that the shadow side does not appear so dark. If, in addition, a sheet of white paper or cardboard is held at C D the light will be reflected on to the shadow side of the sphere, to the great advantage of the lighting or modelling. This illustrates both the principles and practice of indoor portrait lighting, the window being represented by the candle and the sitter by the sphere. The only way of securing satisfactory results is by diffusing the light and using a reflector. G is a diagram of an ordinary room having corners D, E, F, G. Should there be two or more windows on opposite sides, all but one of these should, in most cases, be blocked up, as otherwise the cross-lighting will produce unsatisfactory results. One window is really all that is required, and it must be one into which the sun does not directly shine. By placing the camera at C against the blocked-out window (the background at B) and the sitter at S, one would, if neither reflector nor diffuser be used, get a harsh result because all the light would come from the window side. Therefore, tissue paper is placed over the bottom half of the window and the top half is left clear. The blind can be worked over the top half so as to admit or block out top light as desired. A reflector—white paper, cardboard, or a sheet—should be

equally good results, and the position of the camera can also be altered. Even the difficult "Rembrandt" lighting can be secured by placing the camera and sitter somewhere about H and I respectively. Diagrams H to M (based on illustrations appearing in the *Photo Revue*) show six kinds of lighting obtainable in such a room. The letters indicate the position of window W, sitter S, camera C, background B, and reflector R, and the arrow indicates the direction in which the model is looking. The lightings illustrated are: H, ordinary lighting with one window; I, normal lighting with two windows; J, "Rembrandt" lighting; K and L, profiles with different lightings; M, "against the light" effect.

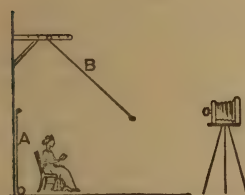
In some cases a large and suitable window may be available at the end of a corridor or in a room which does not permit of the camera being placed in the positions shown in the diagrams. An American worker (W. C. Vivian), who produces excellent work, has such a window and he adapts it as shown in diagram N. He uses two curtains, one, A, dark and opaque, to pull up from the floor high enough to serve as a background for the figure; this will necessitate the camera being pointed directly at the window. The top curtain, B, which is drawn down and into the room to reflect the light from the window on to the figure, should be drawn far enough below the top of the dark curtain to prevent direct rays of light from entering the lens. The top of a white curtain rests on brackets which project out from the wall several feet, with notches to enable one to shift the curtain to or from the window top, by which means there may be obtained an over-head light or a more direct light on the face, as may be required.

A very simple system of lighting heads is shown at O. A window should be fitted with a long white blind, which is pulled down (or out) as far as possible, and suspended above a sitter posed against the window. The top part serves as a reflector for top light, while the lower acts as a reflector for side light. The light at the window is controlled by means of tissue paper or muslin.

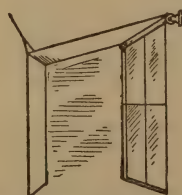
Hints on work in the studio are given under the heading "Studio Portraiture."

POSING

In photography the posing of the figure has to be considered from a different standpoint from



N. Controlling Lighting with Two Curtains



O. Simple Arrangement for Lighting Heads

used at R, and the degree of reflection regulated by its size and the angle at which it is placed. Too much, however, must not be expected from the home studio, and the beginner will do well to attempt nothing but busts unless the

what would be suitable in painting, on account of the exaggeration of perspective in short-focus lenses. Care should be taken so to pose a figure that the whole arrangement of figure and dress is as much in the same plane as possible. With sitting figures, the chair should be placed slightly turned to one side, so that the legs and feet do not unduly extend into the foreground. The arms and elbows should rarely be allowed to rest on both arms of the chair, but ease of pose is often obtained by resting on one arm—the one farther from the camera; in photographing ladies, it is in most cases better to avoid the use of chairs with arms, as a much more graceful pose can be obtained by allowing the dress to fall over the side of the chair. The standing figure allows of much variety of pose, in which the hands play a very important part, but great care must be taken to see that they are so arranged as not to appear awkward. If the body is turned so as to present a side view to the camera, one foot—preferably that farther from the camera—should be advanced in front of the other. Should one arm hang down at the side towards the camera, it should be slightly bent. The hand should be in such a position that the breadth of the back of the hand does not show, but turned so as to show its side and therefore narrowest view; the fingers should be arranged so that the index finger forms a continuation of the chief line.

When the profile is pretty, the head may assume a looking-down position, but such poses need careful arrangement, and there should be an obvious reason for the position. In such a position, and should a book be held, avoid any parallel position of the two arms; this is easily done by holding a top corner of the book with one hand and with the other the diagonal corner. Sunshades, fur boas, and ribbons, all provide useful accessories for obtaining graceful poses by giving opportunities for the arms to be raised in many different positions, always remembering to avoid straight lines and sharp angles which are particularly undesirable.

For head and shoulder pictures, the model may sit on a chair having a small and somewhat high seat. Allow the figure to lean slightly forward away from the back of the chair, as this avoids any appearance of rigidity. The head turned in a slightly different position from the direction of the body gives a suggestion of alertness.

POSING CHAIRS AND HEAD RESTS

Various kinds of chairs are made for studio use, with a head-rest attached, a revolving seat, and sometimes a platform on castors so that the sitter may be moved to where the best lighting is obtainable without altering the pose. In these days of rapid plates, however, with artificial illuminants to render the operator independent of dull weather, such mechanical aids as the head-rest are falling into disuse, the more so as they tend to render the average sitter uncomfortable and constrained. The modern aim is to make the studio as much like an ordinary room as possible, and to avoid fussy preparations or too deliberate posing. But with some sitters, or where a perfect light is not obtainable, such accessories are very necessary.

POSITIVE

The direct opposite to a negative; a reproduction of the object with lights and shadows as in nature. A photographic print is a positive, but the term is rarely used except to describe pictures upon glass—chiefly transparencies. The word was first used by Sir John Herschel in 1840.

POSITIVE ABERRATION

The most usual form of spherical aberration, in which the marginal rays come to a focus nearer the lens than do the central rays.

POSITIVE BATH (Fr., *Bain positif*; Ger., *Positivbad*)

An indefinite and practically obsolete term applied to the silver nitrate solution used for sensitising collodion positives, to the sensitising solution employed with albumenised and plain salted papers, and also to the tanks or dishes holding these.

POSITIVE FERROTYPE (See "Pellet Process.")

POSITIVE FOCUS

The focal length, or the position of the sharpest image of a distant object when projected by a positive lens. Negative focus is the reverse of this, a negative lens having a degree of concavity sufficient to neutralise a positive lens of any given focal length.

POSITIVE LENS

A lens capable of producing a convergent beam of rays or of projecting a real image. All photographic lenses, and telescopic and microscopic objectives are positive lenses. Formerly a positive lens was necessarily convex in its external form, but recent improvements in glass manufacture have rendered it possible for a positive lens to be made with two blank surfaces, or even to have a small amount of concavity.

POSITIVE PROCESSES

Processes that produce a positive result from direct exposure, as distinguished from processes that yield a negative. The term is correctly applied to all methods of obtaining a positive result, whether by optical means or printing from the negative. The first photographic process, the daguerreotype, was a positive process, and for many years collodion positives were very largely produced, but, strictly, the latter are negatives, the images being formed of a light coloured deposit, while the dark colour of the enamel of the ferrotype or a piece of dark velvet placed behind the glass forms the shadows. A similar result can be obtained on an ordinary dry plate by developing lightly, bleaching the image in mercuric chloride after fixing and washing, and, after again washing and drying, backing it up with a piece of dark velvet. The autochrome and other screen-plate processes are positive after the reversal.

POSITIVES IN COLOURS

There have been many methods of obtaining positives in colours. E. J. Wall, in *American Photography*, has summarised them as (1) the

so-called diazotype processes (fully described under the heading "Diazotype"), in which the action of light on diazo compounds is utilised by the formation of dyes from the compounds thus formed or decomposed by light. (2) That class in which a silver image is obtained in the ordinary way, and then converted into a salt which acts as a mordant for the dye. The second class was first described by Georges Richard in *Comptes Rendus*, 1896, and ten years later Traube, of Munich, patented a process, known as "diachrome," which is the application of Richard's principle. Traube converts a silver image into silver iodide by immersion in—

Iodine	87 grs.	20 g.
Potassium iodide	218 "	50 "
Distilled water to	10 oz.	1,000 ccs.

and then after washing immerses the positive in a solution of a basic dye which immediately precipitates or forms a lake with the iodide and gives a coloured image. Dissolve the iodide in a fifth of the water, add the iodine, stir till dissolved, and add the remainder of the water. The silver iodide is of course opaque, but this may be dissolved out by potassium cyanide or a "hypo" bath containing tannin or tartar emetic, the action of these substances being to prevent the washing out of the dye. After fixation the positive is merely washed, and the image consists of a perfectly transparent dye and is of extraordinary brilliancy and transparency in the shadows. Basic dyes must be used, as so far the only acid dyes which give satisfactory results are those of the triphenylmethane series to which the eosines belong. The following dyes are therefore available: acridine orange, chrysoidine, rhodamine 6 G, rhodamine B, xylene red B, methyl and crystal violet, victoria pure blue B, and all the other victoria blues, methylene blues, methylene green, brilliant, emerald, diamond, and victoria greens, and all the eosine group of dyes which comprises eosine, erythrosine, rose bengal, phloxine, uranine, etc. Compound tints are best obtained by successive baths of different dyes, as mixtures are apt to stain unequally. Frequently, too, good effects may be obtained by first staining up with a basic dye and then applying an acid dye; and if the combinations are suitably chosen, very intense colours may be obtained in this way, as the basic acts as a mordant for the acid dye.

Traube's process has been modified by many workers, Tauleigne and Namias being notable among them.

POSITIVES, DIRECT

The simplest method of obtaining a direct positive upon a dry plate is to expose (avoiding over-exposure) and develop in the usual way, but not fix. After washing, immerse in

Potassium perman- ganate	5 grs.	1 g.
Sulphuric acid	10 mins.	2 ccs.
Water	10 oz.	1,000 "

until the image disappears. Next soak in a weak solution of oxalic acid (4 grs. per ounce, or about 1 g. per 100 ccs.) until the brown stain is cleared from the gelatine. The plate is then

well washed, exposed to actinic light, again developed, fixed in "hypo," and washed. For the re-development the following is excellent:—

Metol	50 grs.	11.5 g.
Sodium sulphite	100 "	23 "
Caustic soda	50 "	11.5 "
Water	10 oz.	1,000 ccs.

The permanganate reversing (or reducing) bath may be replaced by a 5 per cent. solution of ammonium persulphate with 5 per cent. of alum, the weak oxalic bath being omitted.

Major-General Waterhouse recommends reducing the exposure to one-thirtieth of the normal, developing and fixing as usual, but using the following developer:—

Lithium carbonate	50 grs.	11.5 g.
Sodium sulphite	50 "	11.5 "
Eikonogen	50 "	11.5 "
Thiocarbamide (saturated solution)	Few drops	
Water	10 oz.	1,000 ccs.

Another method suitable for very slow plates is to expose, develop until the image is seen on the glass side, wash, and immerse in—

Potassium bromide	500 grs.	115 g.
Iodine	100 "	23 "
Water	10 oz.	1,000 ccs.

until the image is bleached. Then wash, develop with any developer in strong daylight, wash and fix.

Lantern Slides and Bromide Paper.—The above methods may be used, but the late Douglas Carnegie worked out what is considered to be a more certain process. The lantern plate or other slow plate should be backed; it is exposed (avoiding over-exposure), developed with metol-hydroquinone, washed, and immersed for about two minutes in the following reversing bath, which, in hot weather, needs to be diluted:—

Potassium bichromate	75 grs.	17 g.
Nitric acid (pure)	45 mins.	9 ccs.
Water	10 oz.	1,000 "

After bleaching in this bath for a moment only, replace in the developer, rock the dish for about 30 seconds, and then, while still in the developer, expose to light, for say 20 or 30 seconds, at a distance of 1 ft. from an ordinary No. 4 burner. The second development must not be pushed to the point of fogging the background. Fix in an acid fixing bath. Bromide prints may be obtained direct in the camera in the same way, using "glossy" paper; a weaker light (equal to one candle) is placed 2½ ft. distant from the print lying in the dish, and allowed to act until the edges of the paper protected by the rebate begin to darken. The colour is not very pleasing and should be modified by toning, sulphide being preferable.

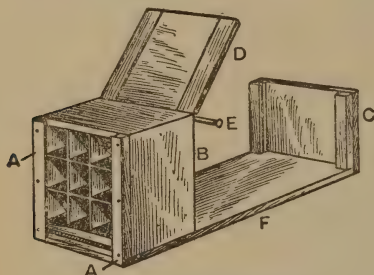
Balagny recommends developing a plate with acid-amidol (see "Amidol, or Diamidophenol"), washing thoroughly, exposing for 30 to 45 seconds to diffused daylight, and then immersing (in the dark-room) in—

Potass. bichromate	150 grs.	35 g.
Nitric acid	60 mins.	13 ccs.
Water	10 oz.	1,000 "

This converts the image into silver chromate, which is dissolved out by a 10 per cent. solution of sodium sulphite plus 3 per cent. of acid bisulphite. The plate is next well washed, when nothing remains but the exposed silver haloids, which are developed with acid amidol minus the bromide.

POSTAGE STAMP PHOTOGRAPHS

For producing these professionally, a camera containing a battery of small lenses may be used, its interior being partitioned into as many sections as there are lenses, thus securing a number of images on one negative. The illustration shows a camera for taking nine photo-



Postage Stamp Camera

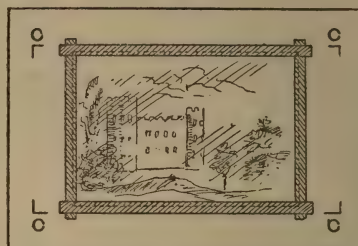
graphs on a quarter-plate. The back of the camera has brass plates A to take the dark-slide; the front is at B; and an easel for supporting the original photograph at C. The box is 6 in. by 5 in., its depth depending on the focal length of the lenses used. For a one-third scale reduction, as in reducing a quarter-plate original to one-ninth that size, the distance between lens and plate will be the focal length of the lenses plus one-third that focal length; the result multiplied by three gives the distance between lens and copy. Thus, with a 3-in. focus lens, $3 + \frac{3}{3} = 4$ in., the distance between lens and plate; while $4 \times 3 = 12$ in., the distance between lens and copy. The divisions are of blackened wood or cardboard partitions. In the front, but not illustrated, are circular openings to take the nine small lenses, and the hinged shutter D is worked by the projecting rod E. The box is attached to a baseboard F. Pinholes could be used instead of lenses, but the exposure would be greatly prolonged.

The camera can be adapted for direct portraiture by providing focusing adjustment, and omitting the easel. Printing from a negative produced in this camera can be done in an ordinary printing frame, using a suitable mask and a multiple border negative for producing the stamp effect. The perforations are done by a special machine, after the backs of the sheets have been brushed over with dextrine and allowed to dry.

In the absence of a special camera, a succession of images can be printed on a single sheet of paper, using a repeating printing frame, and the result may, or may not, be copied in the camera to produce a negative from which a large number of images can quickly be printed.

POSTCARDS

The popularity of the postcard (invented in 1869 by Dr. E. Hermann, of Vienna) has increased enormously since about 1894, owing to the introduction of picture postcards, the authorising of private postcards, and the withdrawal of the

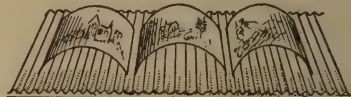


A. Arrangement for Printing Postcards

regulation confining the written matter to one side only. As to who first produced a picture postcard there appears to be some difference of opinion; it is known that at the time of the Franco-German war a French stationer published such a card to commemorate the visit of a popular regiment to his city.

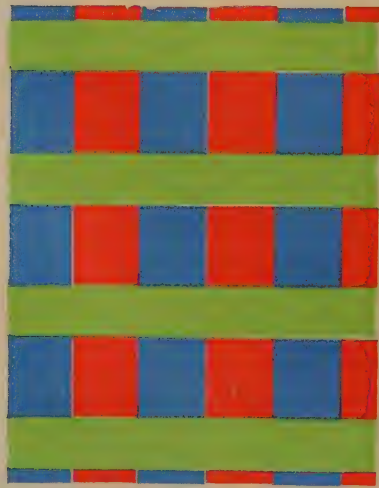
Postcards ready sensitised are supplied by the dealers, or any good cards may be sensitised at home by the blue-print, kallitype, silver or other processes. Plain postcards are sometimes not pure enough to produce the best effects, and it is always better to purchase them ready sensitised with bromide or print-out emulsion, or to obtain the unsensitised cards from a manufacturer of sensitised postcards.

As negatives may be larger or smaller than the average postcard ($5\frac{1}{2}$ in. $\times$ $3\frac{1}{2}$ in.) care is necessary in printing and masking. Many special kinds of postcard printing frames are obtainable, but an ordinary large printing frame can be made to serve. Half-plate is a handy size from which to print a postcard, as the image can then extend right to the edges. Smaller plates than postcard size need masking, which may be done by using a half-plate frame and placing in it a piece of plain glass and a piece of white or light cardboard. In the cardboard is cut an aperture large enough to take the plate. Lantern binding strips are then placed over the junction of the card and the negative (see A), to hold it in position and to serve as a mask for giving a straight edge to the picture. When the correct position of the image on the postcard has been found guide marks c are made on the cardboard to enable cards to be placed in posi-

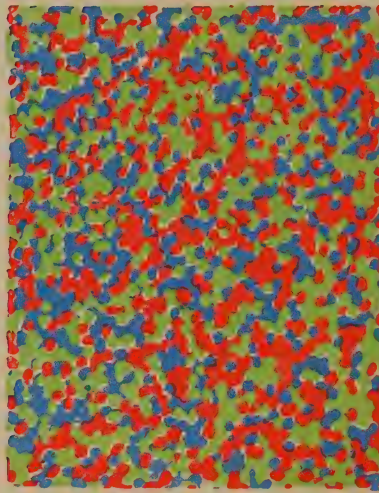


B. Using Corrugated Paper as a Rack for Drying Postcards

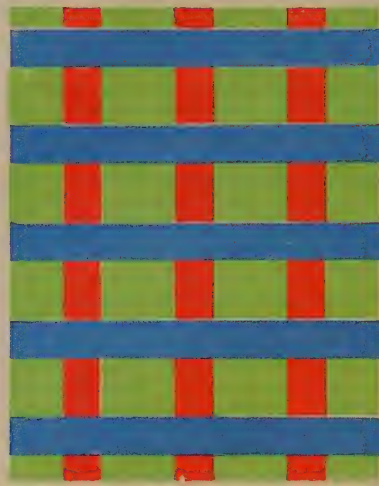
tion quickly (see diagram A). Packets of postcards very often contain black paper masks with openings of various shapes, and these are extremely useful. For the addition of borders, see "Border Printing" and "Borders, Fancy,"



DUFAY DIOPTICHROME



AUTOCHROME



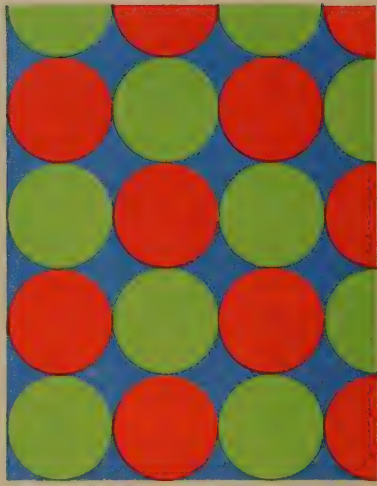
OMNICOLORE



WARNER POWRIE



KRAYN LINE



THAMES

SCREEN PLATES FOR PHOTOGRAPHY IN NATURAL COLOURS

These diagrams, which are based on photomicrographs (magnification, approximately 100 diameters), show enlargements of screen plate patterns

and for the addition of titles, see "Lettering Negatives and Prints." Postcards are exposed, developed, toned, etc., in the same way as other prints, but there is sometimes difficulty in causing them to dry flat. Collodion and most self-toning cards may be dried under pressure between blotting-paper, but gelatine-surfaced cards would be spoilt by such treatment, although the risk would be reduced by hardening with formaline. One of the best ways of drying gelatine cards is to bend them archways, picture side outwards, and catch the ends in corrugated paper as at B. Large producers sometimes nail laths to a board and use the board in the same way as the corrugated paper. The cards generally flatten out naturally when released, or may easily be made to do so, whereas if allowed to dry naturally, they curl inwards and often crack, especially in the case of collodion cards, when any attempt is made to flatten them after drying.

POST-MORTEM PHOTOGRAPHY

Downey's photograph of the body of King Edward VII., the most widely published post-mortem photograph known, indicates that the best results are to be obtained by placing the camera on a level with the head or only very slightly above that level, and showing the face in profile. There should be a dark background, or, failing this, the light should enter the room from behind the camera so as to illuminate the profile, the background being then dark by comparison. The full-face view is less pleasing and more difficult to obtain in the absence of special facilities, which, however, are common on the Continent, where post-mortem photography is widely practised; but photographs of bodies for identification purposes are nearly always taken full-face, and usually in a coffin, the latter enabling the body to occupy a more suitable position for photographing. One of the most serious difficulties in this work is due to the loss of brilliancy in the eyes, which has a large part in determining the characteristic expression of the individual. Bertillon (of finger-print fame) has recommended the injection of glycerine into the eyes, and the restoration of the colour of the lips with carmine.

POTASH ALUM OR POTASSIUM ALUMINIUM SULPHATE (See "Alum.")

POTASSA SULPHURATA

An old name for potassium sulphide.

POTASSIUM AMMONIUM CHROMATE (See "Ammonium and Potassium Chromate.")

POTASSIUM BICARBONATE (Fr., *Bicarbonate de potasse*; Ger., *Saures Kohlen-saures Kalium*)

Synonym, acid potassium carbonate. KHCO_3 . This must not be confounded with potassium carbonate. Molecular weight, 100. Solubilities, 1 in 3 water, almost insoluble in alcohol. A fine white dry powder obtained by treating a solution of potassium carbonate with carbonic acid. It is rarely used in photography. It should not be confused with the carbonate, K_2CO_3 .

POTASSIUM BICHROMATE (Fr., *Bichromate de potasse*; Ger., *Kaliumbichromat*, *Saures Rotes Chromsaures Kalium*)

Synonyms, potash or potassium dichromate; acid or red potassium chromate. $\text{K}_2\text{Cr}_2\text{O}_7$. Molecular weight, 294. Solubilities, 1 in 10 water, insoluble in alcohol and ether. Large orange-red translucent crystals obtained from chrome iron ore. It is poisonous, the antidotes being emetics and the use of the stomach pump, soap, magnesia, or calcium saccharate. It is readily absorbed by the skin, and gives rise in some people to extremely painful indolent ulcers all over the body, but particularly on the hands and arms. Citrine ointment is recommended as the best remedy to apply to the sores, but it is stated that a liberal washing of the hands with salt or sodium bisulphite solution will prevent any ill effects from its use. It is employed in the carbon process and many photo-mechanical processes, as when in contact with organic matter, such as gelatine, fish-glue, and other colloids, it is decomposed by light and renders them insoluble. According to Lumière and Seyewetz the action of light may be represented by the following equation:



The potash immediately acts on excess of the bichromate and forms potassium chromate, which is much less sensitive.

In process work, potassium bichromate is used for sensitising photo-lithographic paper, carbon tissue, collotype plates, and the albumen coating for zinc. The ammonium salt has largely, if not entirely, superseded it for the fish-glue enamel coating. In some formulæ a mixture of the potassium and ammonium salts is used. By the addition of liquor ammoniæ to bichromate sensitising solutions, the double compound of potassium ammonium bichromate is formed and makes a more stable solution. In the Paynetype process a 5 per cent. solution of potassium bichromate is used as a hardening bath. It is also used with sulphuric acid as a glass-cleaning pickle.

POTASSIUM BISULPHITE (Fr., *Bisulfite de potasse*; Ger., *Saures Schwefligsaures Kalium*)

Synonyms, acid potassium sulphite, potassium hydrogen sulphite. KHSO_3 . Molecular weight, 120. Solubilities, soluble in water, insoluble in alcohol. A white crystalline powder smelling of sulphurous acid and obtained by passing sulphurous acid gas into potassium carbonate solution. Occasionally it is used as a preservative.

POTASSIUM BITARTRATE

Synonyms, cream of tartar, acid potassium tartrate. $(\text{CHOH})_2\text{COOH COOK}$. Molecular weight, 198. It is but seldom used.

POTASSIUM BOROTARTRATE (Fr., *Tartrate boro-potassique*; Ger., *Kaliumborotartrat*)

Synonym, soluble cream of tartar. $\text{C}_2\text{H}_3(\text{OH})_2(\text{COO})_2\text{BOK}$. Molecular weight, 214. Solubilities, 1 in 75 water. A fine white powder, composed of equal parts of potassium metaborate

and bitartrate. It has been recommended as a restrainer in development, but is rarely used.

POTASSIUM BROMIDE (Fr., *Bromure de potasse*; Ger., *Bromkalium*)

Synonyms, bromide of potassium or potash. KBr. Molecular weight, 119. Solubilities, 1 in 1.5 water, 1 in 750 alcohol. White cubical crystals prepared by adding bromine to caustic potash or decomposing ferrous iodide with potassium carbonate. It is used as a restrainer in development, and in gelatine emulsion making to form silver bromide. When added to a developer it actually slows the plate—that is to say, it prevents the developer from bringing out the very faintest traces of light action, unless the development is very prolonged.

In process work, potassium bromide is used in making up the copper-bromide intensifying solution for wet-plate negatives. This solution is also sometimes used for bleaching out silver prints which have been drawn upon with pen and ink.

POTASSIUM CARBONATE (Fr., *Carbonate de potasse*; Ger., *Pottasche*, *Kohlensaures Kalium*)

Synonyms, potash, pearlash, subcarbonate of potash, salt of tartar, salt of wormwood. K_2CO_3 . Molecular weight, 138. Solubilities, 1 in .9 water, insoluble in alcohol and ether. A white granular hygroscopic powder, obtained from wood ashes. It is used as the accelerator in development.

POTASSIUM CHLORATE (Fr., *Chlorate de potasse*; Ger., *Chlorsaures Kalium*)

Synonym, chlorate of potash. $KClO_3$. Molecular weight, 122.5. Solubilities, 1 in 16.7 water, slightly soluble in dilute alcohol, insoluble in absolute alcohol. Colourless tabular crystals, obtained by passing chlorine gas into a mixture of milk of lime and potassium carbonate or chloride, or electrolytically from potassium chloride. It is used in the sensitiser for platinum-type paper to give brilliancy to the image, but its chief use is in flashlight mixtures. For the latter purpose the powdered salt should be obtained, and great care must be taken in mixing, which should be done with a feather on a sheet of paper, as the chlorate is very liable to explode with friction.

In process work, it is used with hydrochloric acid to form an etching solution for copper and steel, known as the Dutch mordant.

POTASSIUM CHLORIDE (Fr., *Chlorure de potasse*; Ger., *Chlorkalium*)

KCl. Molecular weight, 74.5. Solubilities, 1 in 3 water, insoluble in alcohol. It occurs in white cubical crystals, and is prepared by neutralising hydrochloric acid with potassium carbonate. It is occasionally used in emulsion making.

POTASSIUM CHLOROPLATINITE (Fr., *Chloroplatinite de potassium*; Ger., *Platinchlorurkalium*)

Synonyms, chloroplatinite or platinochloride of potash. K_2PtCl_4 . Molecular weight, 413.4. Solubilities, 1 in 6 water, insoluble in alcohol.

It is in the form of ruby-red deliquescent crystals obtained by reducing platinum perchloride with sulphurous acid gas or cuprous chloride and adding potassium chloride. It is used chiefly in the platinumotype process and also for toning silver prints.

POTASSIUM CHROMATE (Fr., *Chromate de potasse*; Ger., *Chromsaures Kalium*)

Synonyms, neutral or yellow chromate of potash. K_2CrO_4 . Molecular weight, 194. Solubilities, 1 in 2 water, insoluble in alcohol. It takes the form of lemon-yellow rhombic crystals, and is obtained from chrome iron ore. It is occasionally used as a light filter for sensitometric or three-colour work. The acid chromate is potassium bichromate.

In process work, the chromate has been suggested as a sensitiser in place of bichromates, but it has not come into favour.

POTASSIUM CITRATE (Fr., *Citrate de potasse*; Ger., *Citronensaures Kalium*)

Synonym, tribasic citrate of potash. $K_3C_6H_5O_7 \cdot H_2O$. Molecular weight, 342. Solubilities, 1 in 0.6 water, slightly soluble in alcohol. It is an extremely deliquescent granular powder, prepared by neutralising citric acid with potassium carbonate. It is used as a restrainer in alkaline development, and also in the copper toning bath. In consequence of its deliquescent nature it is as well to prepare this salt in solution. To make 480 grains or 480 g., dissolve 295 grs. or g. of citric acid in 2 oz. or 960 ccs. of hot water, and add gradually with constant stirring 290 grs. or g. of potassium carbonate, or enough to make the solution neutral to litmus paper after heating. Filter the solution and make the total bulk up to 4 oz. or 1,920 ccs., which will give a 25 per cent. solution. The stronger the solution the longer it will keep; when dilute, it is extremely liable to grow mycelium fungus, which may be prevented by the addition of a little salicylic acid.

POTASSIUM CYANIDE (Fr., *Cyanure de potassium*; Ger., *Cyankalium*)

Synonyms, cyanide of potash, cyanide. KCN. Molecular weight, 65. Solubilities, 1 in 2 water, decomposed by heat, slightly soluble in alcohol. It is very poisonous, the antidotes being chlorine water, cobalt nitrate, 10 grains of iron sulphate with 1 dram of tincture of iron in 1 oz. of water, emetics, and ammonia. It should be noted that the gas given off by it is very poisonous also. Occurs in white amorphous deliquescent lumps, and is prepared by fusing potassium ferrocyanide with potassium carbonate in an iron crucible. It is used as a fixing agent in collodion processes, also in Monckhoven's intensifier, and occasionally as a clearing agent for bromide prints.

In process work, it is almost exclusively used for fixing wet collodion negatives, and for the "cutting" or reducing solution. Potassium cyanide is also largely used in electro-deposition, especially in plating with brass and copper, and for cleaning the work before depositing on it.

POTASSIUM DICHROMATE (See "Potassium Bichromate.")

POTASSIUM FERRIC OXALATE (Fr., *Oxalate potassico-ferrique*; Ger., *Kalium-ferric-oxalat*)

$\text{Fe}(\text{C}_2\text{O}_4)_3 \cdot \text{K}_2\text{H}_2\text{O}$. Molecular weight, 491. Solubilities, 1 in 16 water, insoluble in alcohol. It is in the form of bright green crystals, and is prepared by acidulating potassium ferrous oxalate and exposing to light. A convenient solution can be made by adding ferric chloride to potassium oxalate; thus to make 480 grs. or g., dissolve 690 grs. or g. of neutral potassium oxalate in 5 oz. or 2,000 ccs. of distilled water and add 322 grs. or g. of lump ferric chloride dissolved in a little water, and make the total bulk measure 10 oz. or 4,800 ccs. This will be a 10 per cent. solution. It is used in some iron printing processes, but chiefly in Belitski's reducer.

POTASSIUM FERRICYANIDE (Fr., *Cyano-ferride de potassium*; Ger., *Ferrid-cyan-kalium*)

Synonyms, ferricyanide of potash, red prussiate of potash, $\text{K}_3\text{Fe}(\text{CN})_6$. Molecular weight, 329. Solubilities, 1 in 2.5 water, insoluble in alcohol. It takes the form of deep red rhombic crystals, prepared by passing chlorine gas through a solution of potassium ferricyanide. Very frequently the crystals become covered with a yellow powder, which should be rinsed off before use. It is employed in several iron printing processes, but mainly as a reducer for negatives and to bleach bromide prints before sulphiding.

In process work, it is largely used in making up the lead nitrate intensifier, and in conjunction with "hypo" as a reducer for dry-plate negatives.

POTASSIUM FERROCYANIDE (Fr., *Cyano-ferrure de potassium*; Ger., *Ferrocyan-kalium*)

Synonyms, ferrocyanide of potash, yellow prussiate of potash, $\text{K}_4\text{Fe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$. Molecular weight, 422. Solubilities, 1 in 4 water, insoluble in alcohol. It consists of large yellow pyramidal crystals which are obtained by fusing potassium carbonate with horn clippings, wool or hair, and stirring with an iron rod. It is used as a developer in some iron printing processes, and has been suggested as an addition to pyro and hydroquinone developers on the ground that it prevents fog and gives greater density, but it is rarely used for this purpose.

POTASSIUM FERROUS OXALATE (Fr., *Oxalate de fer et potasse*; Ger., *Kalium-ferro-oxalat*)

$\text{Fe}(\text{C}_2\text{O}_4)_2 \cdot \text{K}_2\text{H}_2\text{O}$. Molecular weight, 328. Solubilities, insoluble in water and alcohol, soluble in solutions of an alkaline oxalate or citrate. It is a sandy-yellow powder, obtained by adding potassium oxalate to excess of ferrous sulphate. Although it forms the actual developing agent in iron development, it is rarely used in the dry state, it being more convenient to make it as described under the heading "Ferrous Oxalate."

POTASSIUM FLUORIDE (Fr., *Fluorure de potassium*; Ger., *Fluorkalium*)

$\text{KF} \cdot 2\text{H}_2\text{O}$. Molecular weight, 94. Soluble in water. It is a white granular powder, prepared

by saturating hydrofluoric acid with potassium carbonate. It is used for stripping films from glass negatives; the negative to be stripped should be immersed in a 2 per cent. solution for 5 minutes and then immersed in a 2 per cent. solution of sulphuric acid, when the film readily lifts. It is more convenient than hydrofluoric acid, as it keeps better and is less liable to attack the mucous membranes, lungs, or skin.

POTASSIUM HYDRATE (Fr., *Potasse caustique*; Ger., *Aetzkali*)

Synonyms, caustic potash, potassium hydroxide, KHO. Molecular weight, 56. Solubilities, 1 in 4 water, slightly soluble in ether, 1 in 2 alcohol. It is poisonous, the antidotes being vinegar, lemon juice, oil, and milk; it should not be handled, as it is an extremely powerful escharotic and burns the skin. It is in the form of white sticks, which are obtained by decomposing potassium carbonate with milk of lime. It is extremely deliquescent, and readily attacks both corks and glass stoppers, so that these should be well paraffined or vaselined. It is chiefly used in alkaline developers.

In process work, the crude caustic potash (American black ash) is largely used for cleaning old negative glass, for cleaning the resist and ink off zinc and copper plates after etching, and for cleaning work previous to electro-deposition.

POTASSIUM HYDROGEN SULPHITE (See "Potassium Bisulphite.")**POTASSIUM IODIDE** (Fr., *Iodure de potassium*; Ger., *Iodkali*)

Synonym, iodide of potash, KI. Molecular weight, 166. Solubilities, 1 in 0.75 water, 1 in 18 alcohol, .8 per cent. in collodion. It is in the form of white cubical crystals, which are obtained by adding iodine to caustic potash solution. It is used in emulsion making and for preparing the mercuric iodide intensifier.

POTASSIUM METABISULPHITE (Fr., *Métabisulfite de potassium*; Ger., *Kalium-metabisulfit*)

Synonym, metabisulphite of potash, $\text{K}_2\text{S}_2\text{O}_5$. Molecular weight, 222. Solubilities, 1 in 3 water, insoluble in alcohol. It takes the form of clear transparent crystals smelling of sulphurous acid gas, and is obtained by passing sulphurous acid gas through potassium carbonate solution and adding absolute alcohol. It is used as a preservative in developers and for acidulating the "hypo" bath.

POTASSIUM NITRATE (Fr., *Azotate de potasse*; Ger., *Salpetersaures Kali*)

Synonyms, nitrate of potash, nitre, saltpetre. KNO_3 . Molecular weight, 101. Solubilities, 1 in 3.8 water, very slightly soluble in alcohol. It occurs native and is also obtained by decomposing lime clays with urine. It is usually met with in a fine white powder or prismatic needles, and is used in the manufacture of pyroxyline and in flash powders.

POTASSIUM NITRITE (Fr., *Azotate de potassium*; Ger., *Kalinitrit*)

KNO_2 . Molecular weight, 85. Solubilities, 1 in 1 water, insoluble in alcohol. It occurs in

white deliquescent sticks. It is occasionally used for making actinometer paper. It must not be confounded with potassium nitrate.

POTASSIUM OXALATE (Fr., *Oxalate neutre de potasse*; Ger., *Neutrales Oxalsäures Kali*, *Kaliumoxalat*)

Synonym, neutral oxalate of potash, $K_2C_2O_4 \cdot H_2O$. Molecular weight, 184. Solubilities, 1 in 3 water, insoluble in alcohol and ether. It occurs in white crystals, and is obtained by saturating oxalic acid or acid oxalate of potash with potassium carbonate. It is used in the ferrous oxalate developer and for developing platinotypes, and must be either acid or neutral.

POTASSIUM PERCARBONATE (Fr., *Per-carbonate de potasse*; Ger., *Kaliumpercarbonat*)

$K_2C_2O_8 \cdot H_2O$. Molecular weight, 216. Solubilities, 1 in 15 water. It is a white crystalline powder obtained by electrolysis of potassium carbonate. It is used as a "hypo" eliminator, and is sold under fancy trade names.

POTASSIUM PERCHLORATE (Fr., *Perchlorure de potassium*; Ger., *Ueberchlor-säures Kali*)

$KClO_4$. Molecular weight, 138.5. Solubilities, 1 in 65 water, insoluble in alcohol. It is in the form of colourless rhombic crystals or powder. It is used in flashlight mixtures, and the same precautions should be taken in mixing this as with potassium chlorate.

POTASSIUM PERMANGANATE (Fr., *Permanganate de potasse*; Ger., *Uebermangansäures Kali*)

Synonym, permanganate of potash, $KMnO_4$. Molecular weight, 158. Solubilities, 1 in 16 water, decomposed by alcohol. It occurs in violet-black needle-like crystals with green metallic lustre, obtained by fusing manganese peroxide with potassium hydrate or nitrate. It is used to reduce negatives, and when acidulated with sulphuric acid tends to reduce the high lights more than the shadows. In a neutral solution it practically acts as an intensifier, as a manganese salt is precipitated on the silver image which gives it a more nonactinic colour. It is also used as a test for "hypo," as a "hypo" eliminator, and to produce reversal of the image in the Lumière autochrome process.

In process work, a few drops of a 10 per cent. solution of potassium permanganate added to the wet collodion silver bath, when it is suspected of being charged with organic matter, neutralises the bath and combines with the foreign matter, precipitating it as a black powder. The bath should be stirred whilst the solution is being added, and when it assumes a pale violet colour it should be exposed to sunlight. As soon as the bath is clear, it should be filtered and re-acidified.

POTASSIUM PERSULPHATE (Fr., *Persulphate de potasse*; Ger., *Ueberschwefelsäures Kali*)

Synonyms, persulphate of potash, anthion, $K_2S_2O_8$. Molecular weight, 270. Solubilities,

1 in 50 water, insoluble in alcohol. It is in the form of white crystals obtained by electrolysis of potassium sulphate. When dissolved in water it readily parts with its oxygen, and is used to eliminate the last traces of "hypo."

POTASSIUM PHOSPHATE (Fr., *Phosphat de potasse*; Ger., *Phosphorsäures Kali*)

Synonym, monopotassic orthophosphate, K_2HPO_4 . Molecular weight, 174. Solubilities, soluble in water, insoluble in alcohol. It consists of colourless crystals, and is used as an addition to the developer for platinotype paper.

POTASSIUM PLATINOUS CHLORIDE OR POTASSIUM PLATINO-CHLORIDE (See "Potassium Chloroplatinite.")

POTASSIUM SILICATE (Fr., *Silicate de potasse*; Ger., *Kaliwasserglas*, *Kieselsäures Kali*)

Synonyms, soluble glass, potash water glass. Solubilities, 1 in 3 water, decomposed by alcohol. It takes the form of vitreous masses with greenish tinge, and is obtained by fusing fine sand and potassium carbonate. It is usually met with in the form of a syrupy yellowish liquid. It is occasionally used as a substratum for dry plates and for collotype plates.

POTASSIUM AND SODIUM TARTRATE (Fr., *Sel de Seignette*; Ger., *Seignettesalz*, *Rochellesalz*, *Weinsäures Kalinatron*)

Synonyms, Rochelle or Seignette salts, $KNaC_4H_4O_6 \cdot 4H_2O$. Molecular weight, 282. Solubilities, 1 in 1.4 water, almost insoluble in alcohol. It is in the form of colourless transparent crystals or white powder, and is obtained by boiling together cream of tartar and sodium carbonate. Chiefly it is used in printing-out emulsions, to form silver tartrate.

POTASSIUM SUBCARBONATE (See "Potassium Carbonate.")

POTASSIUM SULPHIDE (Fr., *Foie de soufre*; Ger., *Schwefelkalium*, *Schwefelleber*)

Synonyms, liver of sulphur, sulphurated potash, potassium trisulphide, K_2S_3 . Molecular weight, 174. It consists of amorphous masses with the colour of liver, and is obtained by fusing together sulphur and potassium carbonate. It is very deliquescent, and absorbs carbonic acid from the air and gives off sulphuretted hydrogen. It is used to precipitate silver sulphide from spent "hypo" baths. Its old name was potassa sulphurata.

POTASSIUM SULPHOCYANIDE (Fr., *Sulfocyanure de potassium*; Ger., *Rhodankalium*, *Schwefelcyanalkalium*)

Synonyms, potassium thiocyanate, sulphocyanate, or rhodanide, $KCNS$. Molecular weight, 97. Solubilities, 1 in .46 water, soluble in alcohol. It is in the form of transparent deliquescent crystals, and is obtained by fusing together sulphur, potassium carbonate, and ferrocyanide. It is chiefly used in the sulphocyanide toning bath. It is also a solvent of gelatine, and has been therefore suggested for developing over-exposed carbon prints.

POUNCE

A name for pulverised sandarach.

POUNCY'S PROCESSES

Pouncy, of Dorchester, was the first to work in England the carbon process in the form it was invented by Poitevin, the French pioneer in photo-mechanical work. Pouncy invented several processes of photo-lithography. In 1863 he patented a carbon tissue for photo-lithographic transfers. The tissue was made by coating tracing-paper with a mixture of printing ink, asphaltum, benzole, and fatty matter, with or without potassium bichromate. The paper is exposed to light with the plain side next to the negative, developed in turpentine, dried, and transferred to a damp, cold stone.

POUND

In apothecaries' weight, by which formulæ are made up, a pound is 5,760 grs. or 12 oz., and is the equivalent of 373.276 g. (say 373½ g.). In avoirdupois weight, by which chemicals are sold, it is 7,000 grs. or 16 oz., and is the equivalent of 453.59 g. Approximately, 1 kg. = 2.2 lb. avoird. In fluid measure, it is 5,760 mins. or 12 oz., and is the equivalent of 340.8 ccs.

POWDER (OR DRY) DEVELOPERS

Powders which need only to be dissolved in water to form workable developers. Almost any developer may be made up in this way, the quantities sufficient for 10 oz. of water being mixed together and divided into 10 parts, each of which, when required, is dissolved in 1 oz. of water. The powder must be kept as airtight as possible, and should always be packed in waterproof paper and also in tinfoil. The ingredients should be very fine, quite dry and well mixed, and thoroughly dissolved before they are applied to the plates or papers. In many formulæ, of course, it will be necessary to have two packets of powder, one containing the developer proper and the other the alkali, and it is advisable to use distinctive papers—"Seidlitz powder" style. Anhydrous chemicals should be used when possible.

A two-powder metol-hydroquinone developer is given below as a sample formula:—

A. Metol	.	.	240 grs.	50 g.
Hydroquinone	.	.	480 "	100 "
Boric acid.	.	.	120 "	25 "
B. Sodium sulphite	.	.	480 grs.	100 g.
Borax	.	.	120 "	25 "
Sugar of milk	.	.	120 "	25 "

Make up A into 10-gr., and B into 20-gr. papers, and, for use, dissolve one of each in 1 oz. of water.

POWDER PROCESS

This is better known as the dusting-on process (*which see*).

The following, however, was introduced as a powder process, and is based on the reduction of the persalts of iron into proto-salts by the action of light. It was invented in 1858 by H. Garnier and A. Salmon, of Paris, in competition for the award offered by the Duc de Luynes for the purpose of solving the problem of producing absolutely permanent photographs. Well-

sized paper is coated with a strong solution of ferric ammonio-citrate in water; having been dried in the dark, it is exposed under a positive transparency to daylight until the image is faintly visible. The paper is pinned to a flat board, and, by diffused daylight, very dry and fine lampblack or other pigment is brushed over the paper with a pad of cotton-wool or a camel-hair brush. By breathing upon the paper the parts not acted upon by light become somewhat sticky and retain the black pigment; thus, details of the image appear and in time the picture is complete. The print is fixed by immersing in water, which washes out the sensitive iron salts. The print is then dried and varnished.

In process work, there are several methods of powdering to form acid resists. For instance, the so-called "dry enamel" method is a powder process, development being performed by dusting a hygroscopic film of gum and bichromate so that the parts which have not been acted upon by light absorb the powder. These parts are readily cleared away after the plate has been burnt in. There is also the dragon's-blood powdering process, which is very largely used for zinc etching. The Austrian process of zinc etching depends on a method of building up the image with asphaltum powder.

PRAXINOSCOPE

An appliance resembling the phenakistoscope and zoetrope, the motion pictures being seen in mirrors.

PRECIPITATION

The separation of any solid from a solution. It may be chemical, as in the case of the subsidence of barium sulphate from a mixture of sodium sulphate and barium chloride; or it may be due to the lowering of temperature, as when a saturated solution of any salt at a given temperature becomes colder and unable to hold so much in solution.

PRESERVATIVES

Substances which preserve or keep unaltered the original character of any substance. In the early days of collodion dry plates a great number of preservatives (some of which are named under the heading "Coffee Process") were used, which kept the sensitive film moist and acted as halogen absorbers during exposure. In the present day of alkaline developers, such chemicals as sodium sulphite, potassium metabisulphite, nitric acid, etc., are used to preserve the actual developing agent from oxidation. In sensitised papers containing free silver nitrate, citric or other organic acid is used for the same purpose.

PRESS PHOTOGRAPHY

Photography with the object of obtaining illustrations for use in newspapers, magazines, books, etc. All important papers that make a speciality of printing photographs of current events have a permanent staff of photographers, are in touch with agencies which also have a similar staff, and have representatives here, there, and everywhere; they keep a keen look-out for subjects of interest, and make arrangements for recording everything that can be known beforehand. Thus almost the only chance for the

outsider is to be fortunate enough to secure a subject that could not be got by the usual press photographers. Even then he must make haste to turn his advantage to account. It is often advisable to send the undeveloped plate or film with all expedition to the paper likely to use the subject; and, failing that, the negative must be developed, and clean bright prints made at once and dispatched. There are several means of expediting the production of a finished print from a negative, and these must be taken advantage of. Any necessary description or explanation must also be supplied. Then there is the class of work adapted for use in weekly papers and magazines. This sometimes allows of a little more time for preparation and dispatch; but, as before, clean bright prints are essential. Next comes the work that can be used at leisure by various magazines. This often takes the form of a set of prints, probably accompanied by an article which they illustrate. They vary in character according to the publication for which they are intended. They may illustrate tours, travel in out-of-the-way places, various forms of sport and pastime, persons and places of interest, architecture, curiosities, and so forth. Lastly, there is a limited opening for work of a purely pictorial character, and in this class alone is it sometimes possible to employ processes that permit of some control and modification to secure the effect desired.

Although books are frequently illustrated wholly or in part from photographs, it is obvious that such work is already arranged for and does not allow opportunity for casual contributions.

The photographer who aims at supplying prints to the press must possess a keen eye, an alert intelligence for likely subjects and their adaptability for use, and must be a good technical photographer. He must be familiar with the exact class of work likely to be acceptable to any given publication; he must know the addresses of the papers, and the times when matter must be to hand to admit of publication. He should also know the prices to be expected for various kinds of contributions.

The press photographer's outfit depends entirely on the class of work he intends to undertake; and all necessary information is given under separate headings. Cameras of the reflex pattern or with direct-vision finders are the favourites for the usual run of newspaper work. The points to be borne in mind in choosing the lens are definition, covering power, and ability to work at large apertures to allow of short exposures. Quarter-plate, 5 in. by 4 in., and half-plate are useful sizes, as enlargement is an easy matter; in urgent work, enlargement should be left to the process-block maker.

PRESSURE FRAME

A name by which the printing frame is often known, inasmuch as the back portion is so arranged that it presses the sensitive surface into contact with the negative. For paper prints springs are generally employed to give the pressure; but for printing on glass, metal, etc., in process work, screws, wedges, or levers are employed, and in some cases pneumatic or atmospheric pressure.

PRETSCH, PAUL

Born in Vienna, 1808; died, 1873. One of the pioneers of photo-engraving, and an experienced printer. In 1842 he joined the Imperial State Printing Office in Vienna under the direction of Herr Auer, whom he assisted in working out the process of Nature printing. In 1850 he was sent to Paris and London, and in 1851 to London in charge of the Austrian printing exhibits at the Great Exhibition. In 1852, after his return home, he began working out his idea of obtaining galvanoplastic reliefs by the swelling of insolated chromated gelatine films. In 1854, having perfected his discovery so far as to be convinced of its success in a wider field, he gave up his appointment in Vienna and went to London, where he took out an English patent for his process and started to work it in 1855. Many of his plates are exceedingly good, but he found it difficult to make the business pay, and after a serious illness he returned to Vienna in 1863. He was re-engaged at the Imperial State Printing Office, but his health had broken down, and he made no further progress in perfecting his methods. His processes, though no longer worked, laid the foundation of modern photo-engraving. He invented numerous processes; for the one chiefly associated with his name see "Galvanography, Photographic."

PRIMULINE PROCESS (See "Diazotype.")

PRIMULINE YELLOW (Fr., *Primuline*; Ger., *Primulin*)

Synonyms, carnotine, polychromine, thiochromogen, aureoline, sulphine. Soluble in water. It is an aniline dye, bright yellow in colour, consisting of a complex mixture of thio-toluidine sulphonates. It is used in the Diazotype process.

PRINCIPAL AXIS (See "Optical Axis.")

PRINT

An image produced by the action of light on a sensitive surface in contact with a negative or positive transparency. It is usually restricted to an impression on sensitised paper, prints upon glass being known as positives or transparencies.

In process work, the term "print" denotes the image on the metal plate in line and half tone etching.

PRINT INDICATOR (Fr., *Enregistreur*; Ger., *Indikator*)

A device for attachment to the printing frame to register how many prints have been



Print Indicator

made from a given negative. The form illustrated consists of a small metal numbered dial

with a movable hand that catches in slots at each number. Every time a print is removed from the frame the hand is moved one figure forward by the printer, until it is seen that the number of prints it is desired to make have been secured. Other types of print indicators are obtainable.

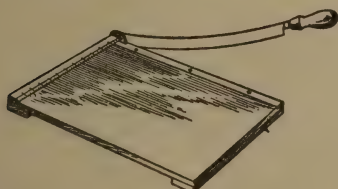
PRINT MEASURER (Fr., *Mesureur des épreuves*; Ger., *Positivmesser*)

An apparatus for measuring the light reflected from different portions of photographic prints. In that designed by Chapman Jones two mirrors, one on each side of an incandescent gas burner, give two beams of light, which enter a velvet-lined box by separate openings, illuminating the print to be tested and a white comparison patch placed beside it. A shadow rod is employed, as in Rumford's photometer, to ensure each patch receiving light only from its own beam. One mirror moves along a graduated scale while the other is fixed. The light on the white patch is reduced by drawing back the movable mirror until the two patches are of equal brightness, when the distance read off on the scale enables an accurate comparison to be made.

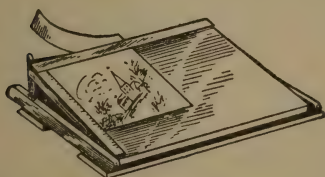
PRINT METER (See "Actinometer.")

PRINT TRIMMER (Fr., *Coupe-épreuves*; Ger., *Beschneideapparat*)

A small machine of the guillotine type, used for trimming prints. The ordinary pattern, shown at A, consists of a baseboard to one side of



A. Print Trimmer with Movable Blade



B. Print Trimmer with Movable Platform

which is pivoted a steel cutting blade having a handle. At a right angle to the blade a graduated rule is fixed to the baseboard. The print is laid on the baseboard and each side is then trimmed in turn by pressing down the blade, using the rule as a guide to the size. Another type of trimmer, B, has a fixed blade and a movable platform or desk. The print is laid on the latter, placing its edge under a steel bar until the part to be cut off projects, and is cut by pressing down the platform, which, on removing the

pressure, springs back ready for the next cut to be made.

The term "print trimmer" is also frequently applied to any kind of knife or wheel-cutter for trimming prints.

PRINT WASHER (See "Washers.")

PRINTER'S INK, PHOTOGRAPHS IN

Apart from the large number of processes by which photographs are reproduced photo-mechanically, there are many on the lines of the following, differing perhaps in matters of detail, but based on the use of a gelatine film, supported by paper or other substance, sensitised with potassium bichromate, printed upon under a negative, washed, and dried. The film is next soaked until the surface repels greasy lithographic ink, applied with a roller, except those parts initially affected by the light through the negative.

PRINTING

The exposing of a sensitive surface in contact with a negative or positive transparency to the action of light. The negative and sensitised paper are held in contact in a printing frame, which is described in a later article, where will be found any necessary instructions for the extremely simple task of taking a print.

In process work, "printing" is the process of exposing the sensitised plate, paper, or tissue under a negative or positive. The taking of a print on paper from the plate after inking-up is termed "proofing" or "proving."

PRINTING BOX

Whilst in ordinary printing it is desirable to avoid parallel rays of light, a diffused light being much preferable, in process work it is sometimes necessary to exclude all except the parallel rays and to cause these to fall at right angles to the negative. This is especially the case in gelatine relief processes, and the method adopted is to place the printing frame at the bottom of a tube or box of from 1 ft. to 2 ft. in length and blackened inside. The box is then tilted to the best angle for receiving the incident light, usually from the sky. J. Wheeler, the inventor of the Metzograph screen, devised such a box for use in connection with his screen. In this box is placed a continuous-tone negative with its glass side in contact with the Metzograph screen, and its firm side in contact with a sensitised zinc or copper plate. A grained image is thus obtained, much the same as would result from printing from a grained negative. Carriers are placed at intervals in the box and at the mouth to mask the light to suit the size of the negative. Wheeler has also suggested the use of this box and screen for silver printing, claiming that it dispenses with retouching of portrait negatives and gives a better modulation of the image.

The use of a printing box in printing from a cracked negative is illustrated under the heading "Cracked Negatives."

PRINTING BY ARTIFICIAL LIGHT

Printing by the ordinary forms of domestic artificial light can be conveniently carried out

only in two processes, bromide and gaslight. The former is sufficiently rapid to give a fully exposed print from a good negative of medium density in twenty to thirty seconds at a distance of three feet from a 16 candle-power light. The latter is much slower, and the same negative would probably require an exposure of one minute at 6 inches from the same light; but this slowness carries with it the advantage of permitting the development, etc., to be performed in very weak white light. When shielding or controlling is necessary, certain differences in working have to be adopted when printing by artificial light, as explained under the heading, "Control in Printing."

Daylight printing processes can be successfully worked by electric arc light.

PRINTING BY DAYLIGHT

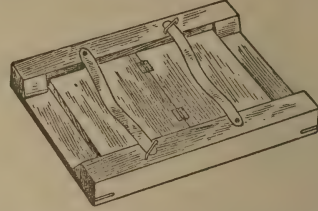
The silver printing-out, platinotype, and carbon process and their many sub-divisions are daylight methods; their sensitiveness is too slight for artificial light to produce any useful impression. The electric arc light may be used for any of these processes. Daylight printing should not be carried out in direct sunshine, because any slight scratch, bubble, or mark on the glass side of the negative would cast a definite shadow during printing and show a white line or mark in the finished result. Printing in the sun is quite impracticable for negatives that have been covered with matt-varnish or tracing paper on the glass side, or that require to be shielded or masked during printing. These methods would always cause definite and harsh lines. A bright diffused light is best for all ordinary printing, the frame lying quite flat, exposed to the sky, when shielding or masking is necessary. It is frequently stated that sunshine will assist in securing soft prints from harsh negatives, and a very feeble light enable more brilliant results to be obtained from weak negatives. Careful experiments have, however, failed to confirm this, the best results being invariably those taken in a very bright diffused light.

PRINTING, COMBINATION (See "Combination Printing.")

PRINTING FRAMES (Fr., *Chassis positif*, *Chassis de tirage*, *Chassis presse*; Ger., *Kopierrahmen*)

Appliances for keeping the negative and sensitised paper in close contact during exposure to light in printing. The ordinary pattern, A, is made of teak or other hard wood, and the divided hinged back, the inner side of which is usually covered with cloth or felt, is fastened by means of two metal springs that engage in bent wire staples. To examine the progress of printing, one spring is unfastened and half the back is raised, keeping a firm pressure meanwhile on the remaining half with the fingers of the other hand in order that the print may not be shifted. Many workers prefer to have the back unequally divided, so that the greater portion of the print may be examined at once. Various frames are now made with a non-slip back, one of the best being that shown at B, in which projecting metal pegs extend from the hinges and fit in metal grooves at the sides of the frame,

effectually preventing slipping. In another pattern the back is hinged directly to the frame. C shows a heavier type of frame, suitable for large sizes, and holding a sheet of plate-glass,

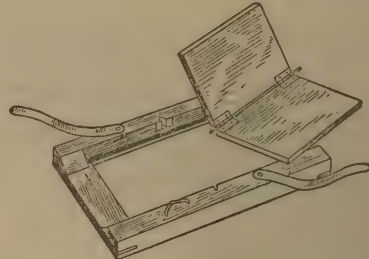


A. Ordinary Pattern of Printing Frame

so that a negative of any size can be used; this has two hinged pressure-bars with springs on their lower side, the bars being fastened down by brass strips which fold over their ends.

For copying plans, etc., large frames are used, with the back divided into several sections, each with its own pressure-bar, as at D.

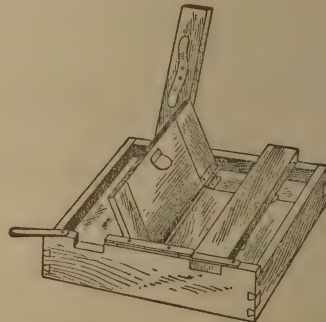
A great variety of frames are specially designed



B. Printing Frame with Non-slip Back

for combination, multiple, and border printing, as well as for postcard, lantern slide, and stereoscopic work.

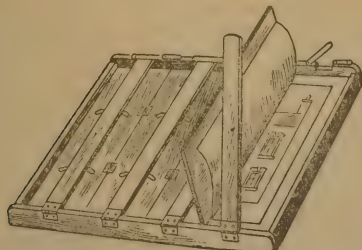
In process work, considerable inventiveness has been displayed in the design of printing frames. For paper prints, spring pressure is relied upon; but for printing on metal plates, etc., screw and wedge pressure is resorted to.



C. Heavier Type of Printing Frame

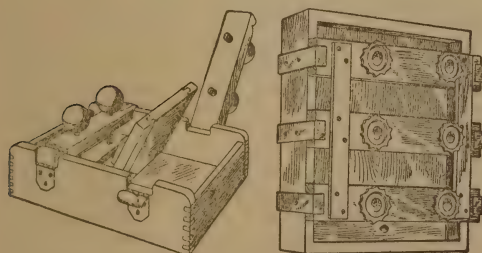
The oldest form of frame for printing on plates has a number of wooden screws inserted in several heavy bars across the back (see B). The screws are now generally iron, threaded into iron bushes

let into the wooden crossbars (*see* F). A further improvement is to make the crossbars of iron and connect them together into a frame or "spider," with crab-like castings attached to



D. Printing Frame for Copying Plans, etc.

the back for taking the thrust of the screws, the number of which has been reduced to two and even to one. The frames are usually made of wood, strengthened by iron clamps to take the strain of the crossbars, or heavy steel screw bolts are passed through from back to front. The front is of plate-glass of from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. thick, while the back is usually of wood heavily clamped, although in America iron backs have been used with the multi-screw frames. For collotype, a wedge pressure is generally preferred, the frame having no back and the wedges pressing directly on the thick glass printing-plate. Frames operating by leverage have come into general use in America; in a popular pattern the bars are pressed down on to heavy pads of rubber by means of a quick-acting cam lever. Vacuum frames are found effective for blue printing, photo-litho transfers, and for printing direct on thin zinc for photo-lithography. These frames consist essentially of a wooden frame in which is mounted a glass plate to form the front. The negative and sensitive surface are laid upon this and backed by a sheet of india-rubber, which is pressed down by another frame around the margin. The air is then exhausted from between the front glass and rubber sheet by means of a vacuum pump, the pressure of the atmosphere on the rubber sheet then producing contact. For thick zinc and copper plates, a pneumatic cushion covering the back of the frame and held down by a heavy back



E and F. Process Printing Frames

board and crossbars is found more effective; after the frame has been shut down the cushion is more fully inflated by means of a pump. A hydraulic pressure frame has also been employed.

PRINTING-IN (*See* "Backgrounds, Printing-in"; "Clouds, Printing-in"; and "Combination Printing.")

PRINTING-OUT

Any method of printing in which a visible image of full depth is obtained by exposure to light. The best-known print-out process is that employing gelatino-chloride silver paper, better known as "P.O.P." (printing-out paper).

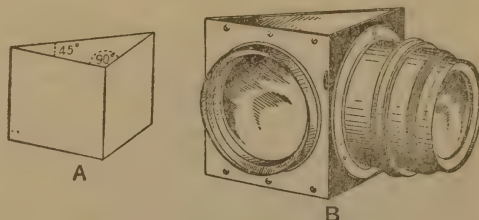
PRINTS STICKING TO NEGATIVES

If negatives or gelatine silver papers are put to print in a damp condition, or if moisture, as from rain, gets in between the negative and print, they will become stuck together. They should not be forcibly pulled apart, but at once plunged into a "hypo" fixing bath and allowed to soak, after which the print (quite ruined) may be pulled away from the negative, which, if the work has been done carefully, ought to be quite unharmed.

In process work, sticking is prevented sometimes by rubbing the negative over with paraffin, or with a trace of vaseline.

PRISM, REVERSING (Fr., *Prisme de renversement*; Ger., *Umkehr Prisma*)

The prism used by process workers and others for reversing images laterally is a block of optical glass free from striae and cut in triangular form (*see* A), so that two of its faces form a right



Reversing Prism

angle to one another, and its hypotenuse is at an angle of 45° . The angles must be correct and the surfaces ground and polished with as much care as those of a lens. The hypotenuse is silvered, and the prism is mounted in a metal box (*see* B) provided with a screwed ring for attaching it to the lens. Usually it is fitted on the front, but some workers prefer it behind the lens. The prism reverses the image laterally, so that it appears the right way on the negative; thus the metal plate printed from the negative has an inverted image which in the final print again comes right. If a prism were not used, any lettering in the final result would read the wrong way round, just as printed matter appears in a mirror. Prisms are preferable to mirrors (*see* "Mirror, Reversing"), as they remain permanently in good condition, whilst mirrors soon become tarnished and require repolishing or resilvering. A slight disadvantage of the prism is that it increases the exposure, but with the powerful electric arc illumination used by process workers this is not noticed.

PRISMATIC SPECTRUM (*See* "Spectrum.")

PROCESS BLOCK

A typographic printing block produced by photo-mechanical processes, as distinguished from a block produced by wood engraving.

PROCESS PLATES

Dry plates prepared specially for photo-mechanical work. They are slower than plates used in general photography, the emulsion being compounded with the object of giving a hard black-and-white image. Two kinds of plates are issued by some makers—"process" for line reproduction, and "half-tone" for making half-tone negatives. In a typical case the speed of the "process" plates is 16 Watkins, $f/28$ Wynne, or 25 H. and D., and that of "half-tone" plates 30 Watkins, $f/39$ Wynne, or 47 H. and D.

PROCESS WORK

A general term embracing all kinds of photo-mechanical reproduction processes.

PROFESSIONAL

Anyone who gets his living by the practice of photography; not necessarily anyone who accepts remuneration for photographic work, as explained under the heading "Amateur Photographer."

PROGRESS MEDAL (See "Royal Photographic Society.")

PROJECTION

The art or act of projecting or throwing an image by means of an optical system. Examples are the projection of a transparency for viewing purposes by means of an optical lantern or kine-matograph (see under both of these headings); the projection by an enlarging apparatus of a negative upon a sensitive surface (see "Enlarging"); the projection of an image by the lens of a camera upon the dry plate; and other methods described under various headings.

PROJECTION, STEREOSCOPIC (See "Stereoscopic Projection.")

PROMENADE

A commercial size of photographic mount, usually $8\frac{1}{2}$ in. by 4 in., but subject to variation. A "promenade midget" generally measures about $3\frac{1}{2}$ in. by $1\frac{3}{8}$ in.

PROOF SPIRIT

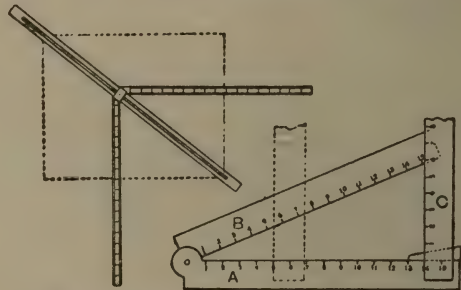
A term which took its origin from an old test for the strength of alcohol, in which a heap of gunpowder was wetted with the spirit and then a light applied. If the gunpowder did not fire, the spirit was "under proof," or "U.P."; if it just fired it was "proof"; and if it immediately fired it was "over proof," or "O.P." At the present time proof spirit should contain 49 per cent. of pure alcohol at 62° F. (nearly 17° C.) (See also "Alcohol.")

PROPORTIONAL SCALES AND RULES

Various forms of proportional scales or rules have been suggested for the use of photographers and process workers, principally with the object of calculating exposures and the proportions of

reductions and enlargements. J. A. C. Branfill's proportional rule, A, has three members, A, B, and C, which form a triangle graduated on three sides. When C is slid along A, any triangle formed will be similar to the original one, and all its sides will be proportional. This enables a fourth proportional to three known quantities to be found. Thus, if it is required to find $\frac{1}{4} \times 6$ by the rule, place C to 14 on A, set B to 6 on C, slide C to 5 on A, when B will be found to cut C at the dimension required. A shows the positions of the members for this calculation.

Another form of proportional rule, but with a definite purpose, is the scalometer of W. Laurence Emmett, for determining which originals are in the same scale of proportion, so that they may be photographed together on the same plate. This instrument is illustrated in the article under the heading "Focusing," and is used as there described. By its means the operator groups up on his copyboard all originals which bear the same proportional number. By



B. Emmett's Sizeometer

A. Branfill's Proportional Rule

a slight variation of the method enlargements may be similarly dealt with. By means of a printed scale sent out with the instrument, it is possible to mark off the base of camera and copying stand with numbers corresponding to those on the instrument, so that the camera can be instantly set to the proportion number marked on the original, no focusing being then required. A rule and system having the same object was designed and introduced in America by A. Fruwirth, who also applies scales to the base of the camera. Geo. H. Benedict, of Chicago, has a system worked with a chart of curves. All these methods have the same object, that of setting the camera to the proportion of the original without the necessity of focusing.

Various rules and scales have been devised for determining the second dimension of a reduction or enlargement, one dimension being given. The sizeometer, B, is a good example of a rule for this purpose. The slotted rule is laid on the diagonal of the photograph, and the right angle rule is then brought down to the dimension of one side of the picture. The second dimension is then read off on the other limb. Carl Norman's proportional rule consists of a strip of stretched elastic bearing a numbered scale, the elastic being mounted between two

clamps, so that one of them can be made to slide along and thus alter the length of the elastic ribbon, the scale on it altering proportionally. Thus, the elastic is stretched until a number on it corresponds to the required dimension of the original. Then without altering the elastic the other dimension of the original is measured, and the result is the second dimension.

A further series of proportional scales are those used for measuring the surface area of blocks. Branfill's chart (it consists of a series of curved lines) is a good example. The block to be measured is placed up to the top and left-hand border line, and the required dimension read off on the curved line adjoining the lower right-hand corner of the block. Geo. H. Benedict, of Chicago, is the author of a similar chart. Another form of chart for the same purpose is ruled off into $\frac{1}{4}$ -in. squares, and the figures denoting the square measurement are placed progressively in these squares.

PRUSSIAN BLUE (Fr., *Bleu de Prusse*; Ger., *Berliner Blau*, *Preussischer Blau*)

Synonyms, ferric ferrocyanide, Paris blue, mineral blue, Berlin blue. $\text{Fe}_4\text{Fe}_3(\text{C}_6\text{N}_6)_3$. Molecular weight, 860. Insoluble in water and alcohol. A dark blue powder obtained by precipitation of ferric salts with potassium ferrocyanide. It forms the blue image in the cyanotype and other iron printing processes.

PSYCHIC PHOTOGRAPHY

Known also as "spirit photography." Many persons have claimed to be able to photograph psychic and astral forms; hence the name. Psychic photographs are divided into many classes, including (1) Portraits of psychic entities not seen by normal vision. (2) Pictures of objects not seen or thought of by the medium, photographer or sitter, such as flowers, lights and emblems. (3) Pictures having a flat effect and the appearance of having been copied from others. (4) Pictures of materialised forms visible to normal sight. (5) Pictures of the "wraiths" or "doubles" of persons still in the flesh. (6) Portraits on plates which developers have failed to bring into view, but which, it is said, can be seen on the prints by certain persons; and (7) Portraits that cannot be classed as photographs because no camera is used. The art originated in America in the year 1861, when W. H. Mumler, of Boston, opened a studio specially for the work. The first psychic photographs to be taken in England, it is believed, were those produced by Mr. and Mrs. Guppy, in March, 1872.

Psychic photographs are often called ghost photographs, but the latter term is more often used to describe "faked" or "trick" pictures, which may be produced in many ways, the easiest being to dress up a person in ghostly attire, pose the "ghost," give a very brief and incomplete exposure, cap the lens, and allow the "ghost" to move out of the scene, and then complete the exposure. When the plate is developed a faint image of the ghostly figure is seen, and objects appear through the figure, more or less according to the relations of the exposures.

Another method to adopt is to draw a ghost,

or to paste a drawing of a ghost, upon a piece of dead-black card, and to copy this in the camera. The undeveloped plate is then used to take a photograph in the usual way and developed, when the two images will appear together. Much depends on the relations of the two exposures, as experiment will easily show.

PSYCHOGRAPHY

The photographing of images retained in the retina of the human eye. Many experiments have been made—notably those by W. Ingles Rogers, in 1896—in this particular direction. The method, in brief, is to gaze steadily at some bright object—say, a shilling—in a good light, and then to enter the dark-room and gaze for about three-quarters of an hour on an unexposed dry plate, whereon, it is claimed, a faint image of the shilling will appear on development. Whatever may be thought of the method, it is quite a simple matter for any photographer to put it to the test.

PUDDY'S REDUCER

An ammonium persulphate reducer for which the formula is given under the heading "Ammonium Persulphate."

PULL

A proof of a block or of type matter obtained in a hand press in which the platen is lowered to obtain an impression upon the paper by pulling a lever.

PULP SLABS

Thin slabs of polished vulcanite or enamelled composition, to which wet P.O.P. prints are squeezed in order to obtain a glazed surface. Glossy celluloid sheets are also used. (See "Glossy Surfaces on Prints.")

PUMICE POWDER (See "Abrading Powder.")

PUSH PINS

Glass-headed pins used for fixing bromide paper to the easel in enlarging, pinning up prints and films to dry, etc.

PYRAXE

Pyrogallol acid in a compact and crystallised form, which occupies about one-fifteenth the space of ordinary sublimed pyrogallol acid. It is used with potash or soda exactly like ordinary pyro, and any pyro developer can be made up with it by using the same weight of pyraxe as pyro.

The two forms of developer, however, specially recommended are:—

Pyraxe-soda

A. Pyraxe.	70 grs.	16 g.
Sodium sulphite .	2 oz.	220 „
Sulphuric acid .	6 mins.	1'25 ccs.
Or Citric acid .	13 grs.	3 g.
Water to .	10 oz.	1,000 ccs.
B. Sodium carbonate .	1 oz.	110 g.
Water to .	10 „	1,000 ccs.

For use take 1 part A, 1 part B, and 1 part water.

Pyraze-potash

A. Pyraze.	1 oz.	110 g.
Sodium sulphite	2½ "	275 "
Citric acid	7 grs.	16 "
Water to	10 oz.	1,000 ccs.
B. Sodium sulphite	1½ oz.	138 g.
Potassium carbonate	4½ "	495 "
Hot water to	10 "	1,000 ccs.

This is highly concentrated, 14 drops each of A and B being sufficient for 1 oz. of water. Potassium bromide is used for over-exposure, and more water is added for under-exposure.

Use an acid fixing bath after development with pyraze.

PYRO, PYROGALLIC ACID, PYROGALLOL, OR TRIHYDROXYBENZENE (Fr., *Acide pyrogallique*; Ger., *Pyrogallol, Pyrogallussäure*)

$C_6H_3(OH)_3$. Molecular weight, 126. It occurs in fine white feathery crystals produced by sublimation, and in heavy prismatic crystals of a more compact form (see "Pyraze"). It is sold generally in blue bottles containing 1 oz. It is easily soluble in water, alcohol, and ether. It is not actually an acid, being neutral to litmus. It was introduced as a developer by F. Scott Archer, in 1851, at which time it was very expensive, the price, six years later, being one shilling a dram. For many years it was the principal developer used in the earlier processes, and later for dry plates. In its earlier days it was generally used with ammonia, which was gradually superseded by sodium carbonate, and to only a slight extent by potassium carbonate. As it readily oxidises when exposed to the air, the action being still more rapid in solution, it is necessary to use a preservative, which is generally potassium metabisulphite or sodium sulphite; in the latter case the solution should be acidified with citric, sulphuric or sulphurous acid. The most convenient way of keeping pyro is in a 10 per cent. solution, an average formula for which is:—

Pyro	1 oz.	110 g.
Potass. metabisulphite	36 grs.	8 "
Water	10 oz.	1,000 ccs.

The pyro is added last. Every 10 drops will contain approximately 1 gr. of pyro. Should other preservatives be preferred the following formula may be used:—

Pyro	1 oz.	110 g.
Sodium sulphite	4 "	440 "
Citric acid	30 grs.	7 "
Water (warm) to	10 oz.	1,000 ccs.

The citric acid may be replaced by 10 mins. of sulphuric acid or 60 mins. of sulphurous acid. Dissolve the sodium sulphite in about 7 oz. of water, add the acid, then the pyro, and finally the remainder of the water. This will also contain about 1 grain of pyro per 10 drops, so that any formula containing pyro can be made up from it. Pyro combines with ammonia, soda, potash, metol, acetone, etc. It may stain negatives, hands and linen badly. Pyro-developed negatives have a more or less strongly pronounced yellow or greenish-yellow stain, and therefore print more slowly and give greater

contrast than clean negatives in which the image consists of plain developed silver, although the density may appear the same.

PYRO FOR BROMIDE PAPER

Pyro when properly used gives exquisite brown tones on bromide papers, the pyro-acetone formula being perhaps the best:—

A. Pyro	220 grs.	50 g.
Sodium sulphite	1,320 "	300 "
Sulphuric acid	30 mins.	6.25 ccs.
Water to	10 oz.	1,000 "
B. Acetone	½ oz.	55 g.
Water to	10 "	1,000 ccs.

Use equal parts of A and B. The tone can be altered by varying the quantity of acetone.

The following formula also gives good colours, but the mixed developer should be used for one print only. Solutions A and B, mixed in equal parts, may be used for lantern slides. Four solutions are required, from which two working solutions are made up, one for the actual development and one for clearing:—

A. Pyro	55 grs.	13 g.
Potassium metabisulphite	40 "	9 "
Sodium sulphite	1 oz.	110 "
Water to	10 "	1,000 ccs.
B. Sodium carbonate	640 grs.	146 g.
Water	10 oz.	1,000 ccs.

A developer ready for use consists of equal parts of A and B.

C. Potassium permanganate	240 grs.	55 g.
Water	10 oz.	1,000 ccs.
D. Common salt	1 oz.	110 g.
Water	10 "	1,000 ccs.
Sulphuric acid	4 drms.	50 "

The clearing solution is made by adding ½ oz. of D and 15 mins. of C to 10 oz. of water. The developer (A and B) is poured over the bromide paper, which, when fully developed, is rinsed in water and then flooded for not longer than 30 seconds with the clearing solution. It is next washed for about a minute and fixed in an acid fixing bath, preferably potassium metabisulphite and "hypo."

Dr. Just's pyro developer is as follows:—

A. Pyro	20 grs.	4.5 g.
Glacial acetic acid	18 mins.	4 ccs.
Potassium metabisulphite	9 grs.	2 g.
Sodium sulphite	150 "	34 "
Water	10 oz.	1,000 ccs.
B. Potass. carbonate	85 grs.	20 g.
Water	10 oz.	1,000 ccs.

Use equal parts of each. The developer is almost colourless at first, but rapidly turns brown. For many papers the addition of 6 drops of a 1 in 50 solution of potassium bromide to each 4 oz. of mixed developer is necessary. After development the print should be rinsed in a clearing bath of very weak acetic acid in order to remove stains, and is then washed and fixed in an acid bath. The addition of a few grains of hydroquinone to the pyro solution has been advocated.

PYRO STAINS ON NEGATIVES

These are of a yellow colour, and are caused by exposure of the film when wet with the developer to the air, or by using insufficient sodium sulphite in the developer. It is not all workers who object to them. To obviate them, use a 10 per cent. solution of sodium sulphite or a 2½ per cent. solution of potassium metabisulphite instead of plain water for diluting the stock developer. If a stained negative has not been dried, the use of a 2 per cent. solution of caustic soda will remove some of the stain. If it has been dried, it is rather more difficult; but the following will be of help:—

Thiocarbamide . . .	30 grs.	7 g.
Citric acid . . .	60 „	14 „
Chromic alum . . .	30 „	7 „
Water to . . .	6 oz.	600 ccs.

Soaking in the following (introduced by B. J. Edwards, in 1883), clears the stain to some extent:—

Alum . . .	½ oz.	55 g.
Citric acid . . .	½ „	55 „
Ferric sulphate . . .	1½ „	165 „
Water to . . .	10 „	1,000 ccs.

Berkeley's solution will act if the stains are not of long standing:—

Alum . . .	1 oz.	110 g.
Sulphuric acid . . .	2 drms.	25 ccs.
Water . . .	10 oz.	1,000 „

Wash thoroughly after any of the above baths.

Namias recommends dissolving 48 grs. of ammonium persulphate in 5 oz. of water, and, in order to destroy the reducing action, adding a few drops of liquor ammoniæ. The stained negative is immersed in this, rocked until the stain disappears, and then well washed.

Chapman Jones, in 1890, stated that all clearing solutions hitherto proposed were founded upon wrong principles, as alum (first used for the purpose by Sir W. J. Newton in 1855) actually retards the washing away of stains, inasmuch as it hardens the film; further, acids, although they lighten the colour of the stains, render them insoluble. He considers a weak solution of caustic soda to be the best clearing solution, as the staining matter is kept in a soluble condition, so that it may really be washed away, and it is also kept in its original highly coloured form, so that its removal can be noticed.

PYRO-ACETONE

A one-solution pyro-acetone developer is given under the heading "Acetone." The following is a two-solution form:—

A. Pyro . . .	180 grs.	41 g.
Sodium sulphite . . .	4 oz.	440 „
Water . . .	10 „	1,000 ccs.
B. Solution A . . .	5 oz.	500 ccs.
Water . . .	15 „	1,500 „
Acetone . . .	2 „	200 „

B is the developing solution proper, and it must be neutral or faintly alkaline, certainly not acid; if, on testing, there is any acidity, add sodium carbonate.

Metol combines well with pyro and acetone as follows:—

A. Pyro . . .	60 grs.	14 g.
Metol . . .	80 „	18 „
Citric acid . . .	7 „	1.6 „
Sodium sulphite . . .	360 „	84 „
Water, hot . . .	10 oz.	1,000 ccs.
B. Acetone . . .	240 grs.	55 g.
Water . . .	10 oz.	1,000 ccs.

Add 1 dram of each to 1 oz. of water when required for use.

PYRO-AMMONIA

The use of pyro with ammonia as a developer dates from 1862, and it had its origin in America, where ammonia was first used for fuming dry plates before the application of an acid solution of pyro. Major Russell, the author of the tannin process, was the first (in 1863) to publish full working particulars. The composition of an average developer, ready for use, is much as follows:—

Pyro . . .	15 grs.	3.5 g.
Ammonium bromide . . .	14 „	3.25 „
Liquor ammoniæ (.880) . . .	30 mins.	6 ccs.
Water . . .	10 oz.	1,000 „

The following are two-solution developers:—

A. Nitric acid . . .	2 mins.	.4 cc.
Water . . .	10 oz.	1,000 ccs.
Then add pyro . . .	20 grs.	4.5 g.
B. Liq. ammoniæ (.880) . . .	120 grs.	28 g.
Potassium bromide . . .	30 „	7 „
Water . . .	10 oz.	1,000 ccs.

Use equal parts of each.

A developer which nearly corresponds to 10 per cent. solutions is the following, given by Sir William Abney:—

A. Pyro . . .	50 grs.	11.5 g.
Sodium sulphite . . .	150 „	34.5 „
Citric acid . . .	10 „	2.3 „
Water . . .	1 oz.	100 ccs.
B. Potass. bromide . . .	50 grs.	11.5 g.
Water . . .	1 oz.	100 ccs.
C. Liq. ammoniæ (.880) . . .	2 drms.	25 ccs.
Water . . .	2½ „	225 „

Take of A 20 mins., B 30 mins., C 60 mins., and water 2 oz.; 1 oz. of the mixed developer contains approximately 1 gr. of pyro, 1½ grs. of potassium bromide, and 3½ mins. of ammonia.

Pyro-ammonia is largely used for developing lantern slides because of the excellent brown tones which it yields. The J. A. Hodges formula is excellent:—

A. Pyro . . .	1 oz.	110 g.
Sodium sulphite . . .	4 „	440 „
Citric acid . . .	2 drms.	25 ccs.
Water . . .	10 oz.	1,000 „
B. Liq. ammoniæ (.880) . . .	1 oz.	100 ccs.
Water . . .	10 „	1,000 „
C. Ammonium bromide . . .	1 oz.	110 g.
Water . . .	10 „	1,000 ccs.
D. Ammon. carbonate . . .	1 oz.	110 g.
Water . . .	10 „	1,000 ccs.

This will give brown tones on a plate made for black tones if the exposure is prolonged. A mixture of 30 mins. each of A and B and 60 mins. each of C and D should give a rich brown,

inclining to purple. Increasing D and decreasing B gives warmer and more reddish tones.

It should be noted that, while in some formulæ an alkaline bromide is recommended, it is rarely necessary for modern dry plates.

J. B. B. Wellington's two-solution formula gives rich sepia tones:—

A. Pyro	240 grs.	55 g.
Sodium sulphite	2 oz.	220 "
Water to	10 "	1,000 ccs.
B. Am. carbonate	480 grs.	110 g.
Potassium hydrate	360 "	82 "
Am. bromide	240 "	55 "
Water to	10 oz.	1,000 ccs.

Take 1 dram of each, and add water to make 1 oz.

PYROCATECHIN (Fr., *Pyrocatechine*; Ger., *Brenzcatechin*)

Ortho-dihydroxybenzene; known also as oxyphenic acid and catechol. $C_6H_4(OH)_2$. Solubility, 1 in 1·25 of cold water. It was suggested as a developer in 1880, and came into use in 1899. It occurs in prismatic colourless crystals. It does not stain or fog; it turns brown in solution and on exposure to air, but its developing powers are not impaired. It can be used with the carbonates or caustic alkalis, either in one or two solutions, and is not influenced by temperature. The following is a simple one-solution formula for negatives:—

Pyrocatechin	50 grs.	11·5 g.
Sodium sulphite	120 "	27·5 "
Sodium carbonate	240 "	55 "
Water to	10 oz.	1,000 ccs.

This is ready for use.

It may be made up in a highly concentrated form, as follows:—

Sodium sulphite	1 oz.	110 g.
Caustic soda	67 grs.	15 "
Hot water	3 oz.	300 ccs.

Dissolve, and add—

Pyrocatechin	96 grs.	22 g.
Water	1 oz.	100 ccs.

For use, dilute 1 part with 15 parts of water.

A two-solution formula is:—

A. Pyrocatechin	50 grs.	11·5 g.
Sodium sulphite	1 oz.	110 "
Water to	10 "	1,000 ccs.
B. Potassium carbonate or sodium carbonate	288 grs.	66 g.
Distilled water to	10 oz.	1,000 ccs.

For use, mix together equal parts.

Sodium tribasic phosphate is recommended by Messrs. Lumière as an accelerator:—

A. Pyrocatechin	96 grs.	22 g.
Sodium sulphite	1 oz.	110 "
Water	10 "	1,000 ccs.
B. Tri-sodium phosphate	60 grs.	14 g.
Water	10 oz.	1,000 ccs.

Add 1 part each of A and B to 1 part of water.

For bromide paper the following one-solution formula is recommended:—

Sodium sulphite	60 grs.	14 g.
Sodium carbonate	120 "	28 "
Pyrocatechin	20 "	4·6 "
Water	10 oz.	1,000 ccs.

This is ready for use.

PYROLIGNEOUS ACID

Crude acetic acid.

PYRO-METOL (See "Developers, Mixed or Combined.")

PYRO-POTASH

Dr. Eder and others have recommended the use of the alkali potash to take the place of ammonia or soda in the developer. Several advantages have been claimed for it—namely, the stable nature of the alkali and its freedom from fog or stain, but its drawbacks are slow working and possibility of frilling. The average of the many formulæ advocated is:—

Pyro	30 grs.	7 g.
Potassium carbonate	120 "	28 "
Water	10 oz.	1,000 ccs.

Bromide is added as required.

Eder's formula is in a two-solution form, and is much as follows:—

A. Pyro	436 grs.	100 g.
Sodium sulphite	1,090 "	250 "
Sulphuric acid	10 mins.	2 ccs.
Water	10 oz.	1,000 "
B. Potass. carbonate	2,000 grs.	460 ccs.
Sodium sulphite	550 "	126 "
Water	10 oz.	1,000 ccs.

For use, add 135 drops of each to 10 oz. of water. There are many other formulæ.

PYRO-SODA

A developer that is popular on account of soda having many advantages over ammonia, which in 1862 was introduced as an accelerator for pyro. Washing soda is largely used in place of crystallised sodium carbonate, but the latter should always be used when sodium carbonate is mentioned. This developer gives off no fumes as ammonia does, and may therefore be used with greater comfort; it rarely produces chemical fog, and negatives properly developed are of a good printing colour.

The average of twelve of the best-known formulæ is:—

Pyro	30 grs.	9 g.
Sodium sulphite	240 "	55 "
Sodium carbonate	240 "	55 "
Water to	10 oz.	1,000 ccs.

Some workers prefer to make up the developer except the pyro, and add the latter just before use. Lange's (*which see*) is typical.

The Hurter and Driffield standard pyro-soda developer for plate-speed testing is:—

Pyro	8 parts.
Sodium carbonate (crys.)	40 "
Sodium sulphite	40 "
Water to	1,000 "

This should be used at a temperature of 65° F. (18° C.).

PYROTECHNIC LIGHTS (Fr., *Lumières pyrotechniques*; Ger., *Pyrotechnisches Licht*)

Chemical mixtures giving a brilliant light on ignition, at one time used for photography at night and in dark interiors, but now completely superseded by magnesium and the various forms of electric light. Typical formulæ were: (A) Potassium nitrate 28 parts, sulphur 7 parts, arsenic trisulphide (orpiment) 2 parts. This gives off poisonous fumes, and if burnt in a room provision must be made for carrying these off by a chimney. (B) Potassium nitrate 7 parts, sulphur 2 parts, black antimony sulphide 1 part, red lead 1 part. All the ingredients must be dry, and the potassium nitrate not too finely powdered. In this case also the fumes require to be led away.

PYROXYLINE (Fr., *Pyroxylin*; Ger., *Pyroxlin*)

Synonyms, nitrocellulose, collodion cotton, soluble gun-cotton, collodion wool. Solubilities, insoluble in water and in alcohol, soluble in equal

parts of alcohol and ether, and in amyl acetate, acetone, and glacial acetic acid. It is a white flossy substance, resembling cotton, but harsher to the touch and much more friable. It is prepared by the action of nitric acid (or of potassium nitrate) in the presence of sulphuric acid on cotton-wool. The actual chemical formula for this substance is a disputed point, but nearly all photographic pyroxyline consists chiefly of cellulose-tetranitrate with a small quantity of trinitrate; the formula for the former would be $C_{12}H_{18}O_5(NO_3)_4$, and for the latter $C_{12}H_{17}O_7(NO_3)_3$. In the collodion days, it was of paramount importance, but has now—except in process work—become of secondary interest, and is used for prepared collodion, for negative and positive work, and for enamelling prints.

In process work, from 1 to 4 per cent. is used in collodion, but 2 per cent. is general. Celloidin is replacing it more and more on account of its greater uniformity.

**QUADRICOLOUR**

A trade name adopted by an American firm for the four-colour process, the fourth printing being a black, which is printed last. The building up of a four-colour print is exemplified in a plate accompanying this work.

QUARTER-PLATE

A commercial photographic size, $4\frac{1}{4}$ in. by $3\frac{1}{4}$ in., one quarter of a whole plate.

QUARTZ (Fr., *Quartz*; Ger., *Quarz*, *Bergkrystall*)

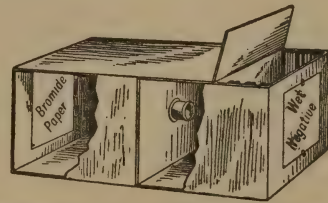
Synonym, rock crystal. Native anhydrous silicates of potash and soda, used for the construction of lenses, prisms, etc., for the examination of the ultra-violet rays.

QUICK PRINTS FROM WET NEGATIVES

The work of taking a print from a wet negative. A sheet of bromide or gaslight paper is soaked in water until quite limp, and the negative placed in the water with it. The two are then brought into contact, film to film, while under water and of course in the dark-room. The negative and paper are removed from the water, the glass side wiped dry, exposure made to the light, and the print developed and fixed in the usual way. A printing frame is not necessary, but if the light used for exposing is very strong it is advisable to shield the back of the paper with a piece of cardboard. The paper should be taken from the wet negative very carefully, and preferably under water. Another plan is to immerse the rinsed negative for five minutes in a 10 per cent. solution of formaline, then in hot water for about two minutes; it should take about five minutes to dry.

The arrangement for enlarging or reducing

direct from the wet negative, shown in the diagram, may be much simplified if set sizes are always used. In one end of an oblong box is cut an aperture to take the wet negative, or it may be dropped into grooves as shown. At the opposite end is a hinged door, to which the paper is pinned. A sliding partition holds the lens. The wet negative is placed in position, ground glass substituted for the hinged door,



Arrangement for Enlarging or Reducing from Wet Negative

and the image focused by moving the partition holding the lens. The box is then taken into the dark-room, where a piece of bromide paper is pinned to the door, which is then closed and the box taken into daylight for the purpose of making the exposure. The size of the box will depend upon the focus of lens used, size of negative, and degree of enlargement or reduction. The advantages of such an arrangement are that the negatives do not need lengthy washing before the print can be made, and that the picture may be reproduced of any size upon the paper. A fixed-focus enlarger for wet negatives is on the lines of the apparatus shown at A in the article "Enlarging by Daylight."

QUICK STUFF

A term applied, in the early days, to accelerators, which hastened development.

QUILLAIA (Fr., *Écorce de quillay*; Ger., *Quillajarinde*)

Synonyms, quillaja, soap, Panama, China or Murillo bark. The dried bark of *Quillaia saponaria* deprived of its peridermis. It is met with in large flat pieces about $\frac{1}{2}$ in. thick, brownish white outside, and smooth, shiny white inside. The powder causes violent sneezing. A semi-alcoholic tincture is sometimes used as an addition to paper emulsions, or the active principle saponine is used in the same way, its purpose being to give smooth, even coating. It has also been used as a vehicle for the pigments for colouring prints.

QUININE SULPHATE (Fr., *Sulfate de quinine*; Ger., *Schwefelsaures Chinin*)

$(C_{20}H_{24}N_2O_2)_2H_2SO_4 \cdot 7H_2O$. Solubilities, insoluble in water, soluble in dilute acids. It is in the form of white, lustrous, fragile, needle-like crystals, obtained from cinchona bark. It is occasionally used when dissolved in dilute sulphuric acid as a screen to cut out the ultra-violet.

In process work, when reproducing drawings in which Chinese white has been largely used, it has been found advantageous to employ a liquid filter consisting of a 1 per cent. solution of quinine sulphate dissolved by the aid of a few drops of sulphuric or nitric acid.

QUINOL

A synonym for hydroquinone.

QUINOLINE AND QUINOLINE BLUE

Synonyms for cyanine.

QUINOLINE RED (See "Chinoline Red.")**QUINOMET** (Fr., *Métoquinone*; Ger., *Meto-chinon*)

Synonym, metoquinone. $C_6H_4(OH)_2 + C_6H_4(OH)(NHCH_3)_2$. Solubility, 1 in 100 of water. A developing compound composed, it is said, of metol and hydroquinone, and introduced by Messrs. Lumière and Seyewetz, of Paris, in 1903. It can be used with or without an alkali. The following is suitable for time exposures:—

Quinomet . . .	24 grs.	5.5 g.
Sodium sulphite (anhydrous) . . .	144 "	33 "
Water . . .	10 oz.	1,000 ccs.

This is ready for use. For "instantaneous" exposures, 300 mins. of acetone should be added, or 100 grs. of sodium tribasic phosphate, or 50 grs. of caustic lithia. The quinomet must be dissolved in the water first.

QUINONE (Fr., *Quinone*; Ger., *Chinon*)

Synonym, benzoquinone. $C_6H_4O_2$. Molecular weight, 108. It is in the form of golden-yellow prisms obtained by oxidising aniline with sulphuric acid and potassium bichromate. Solubilities, slightly soluble in water, soluble in alcohol and ether and alkaline solutions. It hardens gelatine, but stains it deep brown. When dissolved as in the following formula,

Quinone . . .	24 grs.	5.5 g.
Sulphuric acid . . .	96 mins.	20 ccs.
Water to . . .	10 oz.	1,000 "

it acts as a reducer, and, like ammonium persulphate, acts on the high lights more than the shadows. With potassium bromide, thus—

Quinone . . .	24 grs.	5.5 g.
Potassium bromide . . .	120 "	28 "
Distilled water to . . .	10 oz.	1,000 ccs.

it converts a silver image into a reddish brown compound, probably silver oxybromide Ag_2Br_2O , which can be treated with ammonia to form a dark brown image; sodium or potassium carbonate also gives dark brown, and at the same time intensifies; "hypo" reduces the image without changing the colour; sodium sulphite or bisulphite gives greenish brown; and amidol behaves in the same way.

QUINONE INTENSIFIER AND TONER

Introduced in 1910 by Messrs. Lumière and Seyewetz. By adding to solutions of quinone and its sulphonic derivative a sufficient quantity of a bromide or a chloride, and immersing a negative therein, the silver image attains a certain degree of intensification, its colour becoming gradually reddish brown in the case of quinone, and yellowish brown when using the sulphonic quinone. The following are the original formulæ:—

Quinone		
Quinone . . .	22 grs.	5 g.
Potassium bromide . . .	110 "	25 "
Water . . .	10 oz.	1,000 ccs.

Quinone Sodium-sulphonate		
Quinone sodium-sulphonate . . .	45 grs.	10 g.
Potassium bromide . . .	110 "	25 "
Water . . .	10 oz.	1,000 ccs.

The image thus obtained has slight general opacity, which disappears on immersing the plate after a brief rinse in a solution of liquor ammoniæ 1 part and water 10 parts. The quinone-sulphonate gives a more yellowish and less intense action, and the first formula is preferable to the second.

QUINONE REDUCER

Certain quinone bodies in acid solution have been found by Messrs. Lumière and Seyewetz to act as reducers, giving effects similar to those of ammonium persulphate. A formula is given under the heading "Quinone"; another is:—

Sulphuric acid . . .	90 mins.	17 ccs.
Benzo-quinone . . .	22.5 grs.	5 g.
Water . . .	10 oz.	1,000 ccs.

The action is arrested by rinsing in water and then in a sodium sulphite solution (1 oz. in 5 oz. of water), afterwards washing well.

QUINONE SODIUM-SULPHONATE (Fr., *Quinone sulfonate de sodium*; Ger., *Chinonnatriumsulfonat*)

Synonym, benzoquinone sodium sulphonate. $C_6H_4O_2 \cdot SO_3Na$. Molecular weight, 211. For its use, see "Quinone Intensifier and Toner."



A HEAD

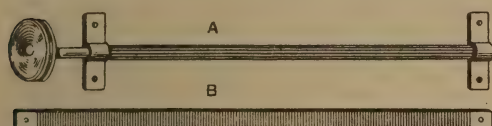
BY J. I. PIGG, F.R.M.S., F.R.P.S.

RADIOGRAPHY, OR X-RAY PHOTOGRAPHY

R

RACK AND PINION (Fr., *Crémaillère*; Ger., *Zahnstange und Getriebe*)

The mechanical device by which the distance between lens and focusing screen is usually regulated. It consists of a steel pinion A working on a brass rack B, the grooves in which engage with the teeth or flutings on the pinion. Generally, two racks are fitted underneath the extension frame of the camera, one at each side,



Rack and Pinion

the pinion being let into the baseboard at a right angle with the racks and worked by a milled-head screw at the side of the camera. For accurate focusing, it is important that the rack and pinion should not be too coarse, and there should be no looseness or shake. Modern cameras have frequently a rack and pinion adjustment to other parts besides the focusing arrangement—for example, on the rising and cross front movements. Rack and pinion adjustments are also fitted to enlarging lanterns, etc.

RACKS, DRYING AND WASHING (See "Drying Rack.")

RADIOACTIVE SUBSTANCES

Substances from which minute particles are continually being propelled at a high velocity. These particles affect the sensitive film of a dry plate or the crystals of certain chemicals which fluoresce when brought into close proximity to the radioactivity; this fluorescence is visible to the eye in a darkened room.

The most important radioactive elements are radium, uranium, actinium, polonium, and thorium, and from these three kinds of radiations are emitted, known as alpha, beta, and gamma rays. The alpha rays are readily absorbed by air or any solid matter which may lie in their path. The alpha particles are of comparatively large size, comparable to that of an atom, and carry charges of positive electricity. They are slightly deflected by a magnetic field. The beta rays are negatively charged, and are strongly deflected by a magnetic field. The particles are much smaller than those of the alpha rays, and are known as electrons. The beta rays are similar to the cathodal rays of an X-ray tube. Gamma rays do not seem to be deflected by a magnetic field, and have the

greatest penetrating powers of any of the rays; they are probably the product of the beta rays.

RADIOGRAPH

A photograph produced by the X-rays.

RADIOGRAPHY (See "X-ray Photography.")

RADIOTINT PROCESS (See "Dansac-Chasagne Colour Process.")

RADIUM (Fr. and Ger., *Radium*)

Atomic weight, 226.5. Radium occurs in pitchblende, an oxide of uranium, in association with uranium, lead, barium, and other metals. It is prepared from pitchblende, or from the residues after uranium has been extracted therefrom. In the preparation of radium, a barium chloride which is highly radioactive is extracted from pitchblende; from this barium chloride, radium chloride is isolated by elaborate processes of fractional crystallisation. One ton of pitchblende yields fifteen pounds of barium chloride, from which only a few grains of radium chloride can be separated.

RAPID DEVELOPERS

Metol, rodinal, and other developers of the newer type (so-called) are often referred to as rapid developers because they produce the image far more quickly than some of the other developers—pyro, for example. As explained, however, under the heading of "Development, Factorial," those images which appear very quickly need developing for a considerable time in order to secure proper density, so that, after all, one normal developer is not so very much more rapid than another. The following table was compiled by Alfred Watkins after making some comparative tests; the final density or printing power was about the same, but the results at the various stages before the desired density was arrived at were very different:—

Developer			Time of appearance in seconds	Factor	Total time (in minutes) of development
Pyro	..	..	16	7	1 $\frac{3}{4}$
Metol	..	..	5	22	1 $\frac{3}{8}$
Ortol	..	..	15	8	2
Aduro	..	..	50	5	4
Kachin	..	..	42	9	6 $\frac{1}{4}$
Hydroquinone	..	..	62	5	5 $\frac{1}{2}$
Glycine	..	..	62	6 $\frac{1}{2}$	7
Metol-hydroquinone	..	..	7	13	1 $\frac{1}{2}$

Thus a mixture of metol-hydroquinone is under normal circumstances the most rapid developer, even though the image takes longer to appear than with metol alone. Pyro-acetone (see "Acetone") without bromide makes a very rapid developer, and gives good negatives of excellent density in three or four minutes. This at first sight appears longer than the time given for pyro or metol-hydroquinone developers in the Watkins table on p. 449, but Watkins used test slips for judging density, and not actual negatives; therefore the times of development given in the table are only comparative, and a rough calculation shows that were pyro-acetone included in the table it would be about 1.

RAPID EMULSIONS (See "Emulsions for Development.")

RAPID PLATES (Fr., *Plaques ultrarapide*; Ger., *Hochempfindliche Platten*)

Plates coated with a highly sensitive gelatinobromide emulsion. Of recent years, the advances in emulsion making have given us plates of very high speed and of general satisfactory freedom from fog. At the present time there is a great craze, particularly among amateurs, for very rapid plates, but in many cases equally as good—if not better—results can be obtained on slower plates, which are usually less prone to chemical fog and possess a much finer grain.

RAPID RECTILINEAR LENS

This, the most popular type of photographic lens, was introduced almost simultaneously by J. H. Dallmeyer and Steinheil in 1866, and held the premier position for all classes of outdoor work until the arrival of the anastigmat. Even now, most moderate-priced cameras are fitted with R.R. lenses, mostly of excellent quality. The rectilinear lens is composed of two cemented combinations, usually symmetrical, and has an initial intensity of $f/8$ (approximately). Either of the combinations may be used singly, but require stopping down to about $f/22$ ($f/11$ of the complete lens) to secure an absolutely sharp image. The rectilinear is an excellent lens for copying, architectural, and process work, while the larger sizes are useful for portraiture. (See also "Rectilinear.")

RAPID SYMMETRICAL LENS

A rapid rectilinear lens, having both combinations of similar construction and of equal focal length.

RAPIDITY

A term applied to the working aperture of lenses (Fr., *Rapidité*, *Clarté*; Ger., *Lichtkraft*), and also the speed of plates (Fr., *Sensibilité*; Ger., *Lichtempfindlichkeit*).

RAY

In optics, a ray of light may be assumed to have the properties of a line in geometry—that is to say, it has length without breadth or thickness. A bundle of rays which converge to or diverge from a given point is called a pencil of rays.

RAY FILTER (See "Colour Screen or Filter.")

RAYOMETER (Fr., *Rayonmètre*; Ger., *X-Strahlen Messer*)

An appliance used in testing the sensitiveness of plates to X-rays. One form consists of a quadrant of aluminium of graduated thickness, the different thicknesses being in concentric steps. The sensitiveness of the plate, as compared with another, is indicated by the thickness of aluminium through which the rays are shown to have penetrated when the plate is developed. The rayometer may also be used to compare the power of different vacuum tubes, by placing it between the excited tube and a fluorescent screen, the thickness penetrated being visible on the screen.

READE, JOSEPH BANCROFT

Born at Leeds, 1801; died at Bishopsbourne, 1870. Chemist, microscopist and photographic experimentalist and discoverer. He was the first to employ "hypo" as a fixing agent (1837), and tannin as an accelerator; he was also the first to produce a negative on paper by means of gallic acid and silver nitrate (1837). He was the first to take photomicrographs with the solar microscope, and these he called "solar mezzotints."

RECORD PRINTS

Photography has unique advantages as a means of producing graphic records of persons, places, and things, for future reference. In spite of the enthusiasm and industry of several associations, the work of securing permanent records is still far from being attacked with systematic completeness, and it is highly desirable that some effective co-ordination of work and control of the results should be instituted. Meanwhile, it would be well if every possible opportunity were seized of making photographic records of any worthy subject, making careful notes of necessary data for future reference. The best view-points and lighting should be considered, and the resulting prints should be made in some permanent process, such as platinum or double-transfer carbon. The work can only be done adequately when the record maker has a knowledge of what is desirable for his attention, and this knowledge is frequently most easily acquired by local workers. Hence the need for a widely distributed army of capable photographers with an interest in record work.

Attention should be devoted first of all to old buildings and their details when there is any likelihood of their near disappearance; to objects of antiquity or historical interest; to natural scenery about to vanish before the builder; to interesting local customs and ceremonies; to obsolete forms of dress and equipment; in short, to anything interesting that is not likely to be seen by future generations and of which a pictorial record will be of value. The results should be entrusted only to the custody of those who appreciate their value and will assure their preservation.

RECTIFIED SPIRIT (See "Alcohol.")

RECTIGRAPH (Fr., *Rectigraphe*; Ger., *Rektigraph*)

A name given to certain makes of doublet lenses. The term is equivalent in meaning to rectilinear.

RECTILINEAR

Capable of reproducing straight lines correctly and without distortion. The term can be correctly applied to any non-distorting lens, including all the anastigmats, but it is usually associated with the older types of doublets known as rapid or wide-angle rectilinears.

RED CHROMATE OF POTASH (See "Potassium Bichromate.")

RED FOG (See "Fog, Colour, etc.")

RED LIGHT (See "Dark-room Illumination" and "Safe Light.")

RED PRINTS

These can be produced by several processes. Carbon prints in red chalk or terra-cotta red are the most perfect and the most satisfactory. Bromide prints toned by the sulphide process can also be made to yield a good red, similar to red chalk. Silver prints, very lightly toned, will be a good red brown, but all rich colours in silver printing tend towards purple brown rather than a pure red brown.

Red prints are often made by printing on plain paper and simply fixing with a "hypo" bath for the purpose of drawing upon in waterproof ink for the bleaching-out process.

RED PRUSSATE OF POTASH (See "Potassium Ferricyanide.")

RED SILVER CHLORIDE (See "Silver Chloride.")

REDCOL

A "cold" enamel process for zinc, introduced by Penrose. The zinc is first coated with a red varnish of a resinous nature forming an acid resist; this is covered with bichromated fish-glue, dried, and exposed under a half-tone negative. The unaltered fish-glue is washed away in development, leaving the red varnish exposed between the dots. The plate is immersed in methylated spirit, which dissolves the red varnish uncovered by the fish-glue image. Next, the fish-glue covering is wiped away, and the image remains in the acid-resisting varnish, and can be forthwith etched, without the burning-in necessary in the fish-glue enamel process.

RE-DEVELOPER

A second development of a plate, either with a similar developer to that first applied or with a modified solution, is possible. Many years ago B. J. Edwards introduced a special method of re-developing over-exposed plates which was very effective.

His special developer should take the place of the normal developer as soon as the over-exposed image flashes up:—

A. Pyro	170 grs.	39 g.
Sodium metabisulphite	170 "	39 "
Water to	10 oz.	1,000 ccs.
B. Sodium carbonate 3 oz. 100 grs.	353 g.	
Potassium bromide 340 grs.	78 "	
Water to	10 oz.	1,000 ccs.

Use equal parts of A and B. The solution is so

highly restrained that it will hardly develop detail, but density goes on increasing.

Re-development forms an essential feature in Wellington's silver intensification process, and also in re-halogenisation. It is also used in some forms of mercurial and chromium intensification.

REDUCERS

Solutions used for reducing the density of negatives, etc. They include potassium ferricyanide in a solution of "hypo" (this is the "Howard Farmer reducer"); potassium permanganate, acidified (this is "Namias's reducer"); ammonium persulphate; ammonium persulphate in combination with sulphite, acidified (this is "Bennett's reducer"); ferric chloride; cerium peroxide. Details of the methods of working will be found under the heading "Reducing Negatives by Chemical Means," and at the references there given.

REDUCERS, COMBINED

Potassium ferricyanide and ammonium persulphate reducers, having respectively different actions upon the density of a plate, have been combined by Coustet (1905). The ferricyanide increases and the persulphate reduces contrast, and the combined reducer is suggested for use with flat and uniformly fogged negatives. For over-exposed or over-developed negatives, Coustet's formula is:—

Ammon. persulphate	200 grs.	46 g.
Potass. ferricyanide	25 "	5.75 "
Sodium hyposulphite	250 "	57.5 "
Water to	10 oz.	1,000 ccs.

The proportions of ferricyanide and persulphate may be varied. Throw away after use. When the negative is of correct density, immerse it in a 10 per cent. solution of sodium sulphite. For the two-solution form use:—

A. Potass. ferricyanide	96 grs.	22 g.
Sodium sulphite	2 oz.	220 "
Water	10 "	1,000 ccs.
B. Ammonium persulphate	192 grs.	44 g.
Water	10 oz.	1,000 ccs.

The negative is placed in A until the brightening action is complete, and then in B until the high lights are reduced, finally well washing.

REDUCIN

A developing substance of German origin, introduced in 1893. It acts very much like amidol. Vogel's formula is:—

Reducin	26 grs.	6 g.
Sodium sulphite	218 "	50 "
Sulphuric acid	5 mins.	1 cc.
Water	10 oz.	1,000 ccs.

REDUCING NEGATIVES BY CHEMICAL MEANS

Most of the methods of reducing negatives modify the gradation by acting to a greater degree at one end of the scale than at the other. The special character of each being known, advantage may be taken of its properties to improve or modify an unsatisfactory negative. The following are the chief methods of reducing negatives by chemical means:—

(1) *Potassium Ferricyanide* in a solution of "hypo" (Howard Farmer's reducer). Prepare a 10 per cent. solution of potassium ferricyanide (red prussiate of potash); this solution will keep indefinitely. When required for use from 10 to 60 mins. of the solution are added to an acid solution of 2 oz. or 2½ oz. of "hypo" in 20 oz. of water. The "hypo" must not have been previously used for any purpose. A solution strong in ferricyanide should be employed if considerable reduction is required; for less reduction a weak solution is more under control. The ferricyanide should be added to the "hypo" at the moment of commencing reduction, as the mixed solution deteriorates rapidly. Soak the plate in water for half an hour before treatment, and rock the dish during reduction to ensure even action. When desired, the negative is withdrawn and well washed. The general quality will be improved by immersing it, after a slight rinsing from the reducing solution, for a few minutes in an acid "hypo" bath of the same strength as that used for mixing the reducer.

This reducer acts more on the weak tones, or shadow portions, of a negative than on the strong tones, or high lights. A moderate reduction of the high lights may be accompanied by complete obliteration of the feeble details in the shadows. It is a very valuable method for dealing with over-exposed, foggy or veiled negatives, since it increases contrasts as it reduces density. The character of the result is not affected by the strength of the solution or proportion of ferricyanide present. A weak solution acting for a long time gives the same result as a strong solution for a shorter time.

(2) *Ammonium Persulphate*.—H. W. Bennett's method is to prepare a stock solution containing ammonium persulphate, sodium sulphite, sulphuric acid (pure), and water; the exact proportions will be found under the heading "Bennett's Reducer." The working solution is a mixture of 1 part of the stock solution and 4 to 8 parts of water.

The negative must be soaked in water for an hour, immersed in the solution, and the dish rocked until sufficient reduction has taken place. The solution will become slightly opalescent or milky in appearance, but this is an indication of its working satisfactorily. When desired, the plate is removed from the solution, rinsed rapidly, and placed for not longer than six minutes in an acid "hypo" bath of the strength already stated, afterwards well washing. A shorter immersion in the "hypo" solution would be sufficient to check the progress of the reduction, but by remaining for six minutes the plate is left in such a condition that subsequent intensification or any other treatment can be successfully applied if desired. Without the "hypo" bath after treatment is practically possible.

The character of the result given by reducing with ammonium persulphate varies according to the degree of reduction. In the early stages the dense parts of the plate only are attacked, and they may be appreciably reduced without any perceptible action on the weak shadow details. With a moderate degree of reduction, the high lights will decrease considerably in strength

with only a slight loss in the shadows. After this, however, the action gains in force in the shadows, and prolonged reduction results in a loss of strength in the shadow details equal in proportion to that of the strong tones. The most useful character of ammonium persulphate is that of correcting or harmonising harsh contrasts, which it accomplishes by reducing the strong tones to a much greater degree than the weak details. But in order that full advantage may be derived from this quality, it is essential that the action should not be prolonged. The plate must be carefully watched, and withdrawn from the solution as soon as any action can be detected in the weaker parts.

(3) *Potassium Permanganate*.—The use of an acidified solution of potassium permanganate followed by a weak solution of oxalic acid for reducing negatives is due to Prof. Namias. The oxalic acid bath, however, is injurious to some plates, particularly those composed of soft gelatine. It softens the film and causes the more transparent parts to become opalescent and useless for printing. With some plates it works satisfactorily. The following modified method of working is quite satisfactory and free from the objections that apply to oxalic acid. Two stock solutions are necessary:—

A. Potassium perman-			
ganate . . .	20 grs.	4.5 g.	
Water . . .	10 oz.	1,000 ccs.	
B. Sulphuric acid			
(pure) . . .	100 mins.	21 ccs.	
Water . . .	10 oz.	1,000 "	

Take 1 dram or 10 ccs. each of A and B, and add sufficient water to make 1 oz. or 80 ccs. For considerable reduction use a larger proportion of A and B. The negative should be soaked in water for an hour, placed in the solution, the dish being rocked until the reduction is sufficient, rinsed rapidly in two or three changes of water, immersed in an acid fixing bath for a few minutes, and then washed and dried. A solution of potassium metabisulphite may be substituted for the acid "hypo," but the latter is preferable. The reduction effected by acidified potassium permanganate is almost uniform throughout the scale, but there is slightly greater reduction in the strong tones than in the weak shadow details.

(4) *Cerium Peroxide*.—This is obtainable in the form of a concentrated solution which keeps moderately well. To 1 drm. of this solution add sufficient water to make 1 oz.; immerse the negative in this until the desired reduction has been attained; then wash and dry. It acts in a greater degree on the shadow details than on the stronger parts, but the difference is not quite so great as in the case of the ferricyanide reducer. The plate, after reduction, is very clean and the image is of a good colour.

(5) *Ferric Chloride*.—This reducer is different in character from the preceding ones. The following stock solution may be prepared, but it does not keep well for more than a few weeks:

Ferric perchloride . . .	60 grs.	14 g.
Citric acid . . .	120 "	28 "
Water . . .	10 oz.	1,000 ccs.

For use, add to ½ oz. of this solution enough water

to make 1 oz. Allow the negative to remain in the bath for about two minutes, rinse, transfer to an acid "hypo" bath for a few minutes, and wash and dry. Longer immersion in the reducing solution will produce no greater effect, as the reduction is a fixed quantity. The degree of reduction is slight, the negative losing about one-eighth of its density uniformly throughout the scale. The operation may be repeated, one-eighth of the strength being removed each time.

Reduction by re-halogenisation is treated in the article on re-halogenisation.

REDUCING NEGATIVES BY MECHANICAL MEANS

These methods are suitable only for local work. One method is to rub down the part that it is desired to reduce by means of a soft rag moistened with methylated spirit. Two thicknesses of soft rag may be stretched over the finger-tip, moistened with the spirit, and rubbed on the plate with a firm pressure. For smaller portions the rounded end of a pen-holder may be substituted for the finger; while for very small details the rag may be held on a small, pointed stick. The film will not be scratched or torn if the rag is kept thoroughly wet with the spirit. Use a new portion of the rag each time fresh spirit is applied, as the used part will probably be black from the deposit worked off the negative. The work should be done on a retouching desk, so that its progress can be watched. As it is purely mechanical, the effect can be graded or varied as desired, and no line of demarcation will show either at the beginning or the end. Halation and similar defects can be very successfully treated by this method.

Baskett's reducer (*which see*) can be substituted for methylated spirit, and used in the same manner. Instead of the metal polish, fine tripoli powder may be used if preferred.

Both of these methods of reducing by mechanical means may be employed very effectively for removing iridescence or surface staining from negatives.

REDUCING PRINTS

Prints can seldom be reduced satisfactorily. Silver prints on P.O.P. may be slightly reduced by means of Farmer's reducer, but if considerable change is attempted the general quality of the print suffers, and the colour is spoiled. It is better to make a new print when possible. Bromide prints may be reduced the same way, or with ammonium persulphate, but it is not desirable to carry the action far or the print will be ruined. For reducing prints, the solutions should be used very much weaker than for negatives, one-fourth of the strength being ample.

REDUCTION AND ENLARGEMENT, CALCULATING DISTANCES IN

The rule for finding distances when reducing is: Divide the longer base of the image to be reduced by the longer base of copy desired, which will give the number of times of reduction; to this add 1 and multiply by the focal length of lens used. The result will be distance between lens and object, and this distance divided by the ratio of image to object will give distance between lens and plate. As an example, assume that a

picture measuring $8\frac{1}{2}$ in. by $6\frac{1}{2}$ in. is to be reduced to a base of $2\frac{1}{2}$ in., using a lens of 11 in. focal length. Then $8\frac{1}{2} \div 2\frac{1}{2} = 3\frac{3}{4}$, number of times of reduction; $(3\frac{3}{4} + 1) \times 11 = 48\frac{3}{4}$, distance from lens to picture; $48 \div 3\frac{3}{4} = 14\frac{1}{4}$, distance from lens to plate. It will be seen from this that the working distance of lens is increased from 11 in. to $14\frac{1}{4}$ in., and therefore the working aperture of the lens is reduced; thus $f/11$ becomes $f/14\frac{1}{4}$, and this factor has to be taken into account when estimating the exposure.

The accompanying table supplies the data for reducing or enlarging a copy, when the focal length of lens is known. The figures given are for linear enlargement; for example, 3 in. to 12 in. = an enlargement of four times, or, vice versa, a reduction to one-fourth. It is important to note that when reducing (copying, slide-making, etc.) the greater of the two numbers given in each square of the table is the distance from the original to the lens, and the smaller number is the distance between plate and lens. When enlarging, the greater of the two numbers is the distance from the lens to sensitive paper, and the smaller number is the distance between lens and negative.

The figures in each square in line with the focal length of lens give the distances on each

TABLE FOR ENLARGING AND REDUCING

Focal length of Lens	Times of Reduction and Enlargement							
	1	2	3	4	5	6	7	8
In.	In.	In.	In.	In.	In.	In.	In.	In.
2	4 4	6 3	8 2 $\frac{2}{3}$	10 2 $\frac{1}{2}$	12 2 $\frac{2}{5}$	14 2 $\frac{1}{4}$	16 2 $\frac{1}{2}$	18 2 $\frac{1}{4}$
2 $\frac{1}{2}$	5 5	7 $\frac{1}{2}$ 3 $\frac{1}{4}$	10 3 $\frac{1}{2}$	12 $\frac{1}{2}$ 3 $\frac{1}{4}$	15 3	17 $\frac{1}{2}$ 2 $\frac{1}{2}$	20 2 $\frac{1}{2}$	22 $\frac{1}{2}$ 2 $\frac{1}{4}$
3	6 6	9 4 $\frac{1}{2}$	12 4	15 3 $\frac{3}{4}$	18 3 $\frac{3}{5}$	21 3 $\frac{1}{4}$	24 3 $\frac{1}{2}$	27 3 $\frac{1}{4}$
3 $\frac{1}{2}$	7 7	10 $\frac{1}{2}$ 5 $\frac{1}{4}$	14 4 $\frac{1}{2}$	17 $\frac{1}{2}$ 4 $\frac{1}{2}$	21 4 $\frac{1}{5}$	24 $\frac{1}{2}$ 4 $\frac{1}{2}$	28 4	31 $\frac{1}{2}$ 3 $\frac{1}{4}$
4	8 8	12 6	16 5 $\frac{1}{3}$	20 5	24 4 $\frac{2}{5}$	28 4 $\frac{2}{3}$	32 4 $\frac{1}{2}$	36 4 $\frac{1}{4}$
4 $\frac{1}{2}$	9 9	13 $\frac{1}{2}$ 6 $\frac{1}{2}$	18 6	22 $\frac{1}{2}$ 5 $\frac{1}{2}$	27 5 $\frac{2}{5}$	31 $\frac{1}{2}$ 5 $\frac{1}{4}$	36 5 $\frac{1}{2}$	40 $\frac{1}{2}$ 5 $\frac{1}{4}$
5	10 10	15 7 $\frac{1}{2}$	20 6 $\frac{2}{3}$	25 6 $\frac{1}{4}$	30 6	35 5 $\frac{3}{5}$	40 5 $\frac{1}{2}$	45 5 $\frac{1}{4}$
5 $\frac{1}{2}$	11 11	16 $\frac{1}{2}$ 8 $\frac{1}{4}$	22 7 $\frac{1}{3}$	27 $\frac{1}{2}$ 6 $\frac{1}{2}$	33 6 $\frac{3}{5}$	38 $\frac{1}{2}$ 6 $\frac{1}{2}$	44 6 $\frac{1}{2}$	49 $\frac{1}{2}$ 6 $\frac{1}{4}$
6	12 12	18 9	24 8	30 7 $\frac{1}{2}$	36 7 $\frac{2}{5}$	42 7	48 6 $\frac{3}{4}$	54 6 $\frac{1}{2}$
7	14 14	21 10 $\frac{1}{2}$	28 9 $\frac{1}{3}$	35 8 $\frac{1}{2}$	42 8 $\frac{2}{5}$	49 8 $\frac{1}{4}$	56 8	63 7 $\frac{1}{2}$
8	16 16	24 12	32 10 $\frac{2}{3}$	40 10	48 9 $\frac{2}{5}$	56 9 $\frac{1}{4}$	64 9 $\frac{1}{2}$	72 9
9	18 18	27 13 $\frac{1}{2}$	36 12	45 11 $\frac{1}{2}$	54 10 $\frac{3}{5}$	63 10 $\frac{3}{4}$	72 10 $\frac{1}{2}$	81 10 $\frac{1}{4}$
10	20 20	30 15	40 13 $\frac{1}{3}$	50 12 $\frac{1}{2}$	60 12	70 11 $\frac{1}{4}$	80 11 $\frac{1}{2}$	90 11 $\frac{1}{4}$
11	22 22	33 16 $\frac{1}{2}$	44 14 $\frac{2}{3}$	55 13 $\frac{1}{2}$	66 13 $\frac{2}{5}$	77 12 $\frac{2}{4}$	88 12 $\frac{1}{2}$	99 12 $\frac{1}{4}$
12	24 24	36 18	48 16	60 15	72 14 $\frac{2}{5}$	84 14	96 13 $\frac{1}{2}$	108 13 $\frac{1}{4}$

side of the lens for copying same size and for enlarging up to eight times. Assume that a whole-plate print is to be reduced to a quarter of its size and that a lens of $5\frac{1}{2}$ in. focal length is to be used. Look for the 4 on the top line (number of times) and for the $5\frac{1}{2}$ in the left-hand column (focal length of lens); where the two columns meet will be found the numbers $27\frac{1}{2}$ and $6\frac{7}{8}$, indicating that the distance between print and lens will be $27\frac{1}{2}$ in. and between lens and plate $6\frac{7}{8}$ in. If, however, a negative is being enlarged four times, $27\frac{1}{2}$ in. will represent the distance between sensitive paper and lens, and $6\frac{7}{8}$ in. the distance between lens and negative.

REDUCTION AND ENLARGEMENT: CALCULATING SIZES OF IMAGES

By means of the simple rule of proportion, sizes of reduced or enlarged images can readily be found. If a print 9 in. $\times$ $4\frac{1}{4}$ in. is to be reduced to measure $2\frac{3}{4}$ in. on its longer edge, then the shorter edge will be as 9 to $2\frac{3}{4}$ so is

$$4\frac{1}{4} \text{ to } x. \text{ Or, } 9 : 4\frac{1}{4} :: 2\frac{3}{4} : x. \quad \frac{4\frac{1}{4} \times 2\frac{3}{4}}{9} =$$

$$\frac{17}{4} \times \frac{11}{4} \times \frac{1}{9} = \frac{187}{144} = 1\frac{23}{144}, \text{ say } 1\frac{1}{6} \text{ in.}$$

A booklet published by Penrose gives tables arranged as here shown:—

$4 \times 3\frac{1}{2} \times 3 \times 2\frac{1}{2}$
<i>Reduces to</i>
$3\frac{1}{2} \times 3\frac{1}{2} \times 2\frac{3}{4} \times 2\frac{1}{4}$
$3 \times 2\frac{3}{4} \times 2\frac{1}{4} \times 1\frac{1}{2}$
$2\frac{1}{2} \times 2\frac{1}{4} \times 1\frac{1}{4} \times 1\frac{1}{8}$
$2\frac{1}{4} \times 2 \times 1\frac{1}{2} \times 1\frac{1}{8}$

Assume that a print 4 in. $\times$ 3 in. is to be reduced. Select a table in which the black figure in the top left-hand corner corresponds to the largest dimension of the original, in this case 4 in. Assume that this has to be reduced to $2\frac{1}{2}$ in. Run down the column under 4 until $2\frac{1}{2}$ is reached. Also run along the top line to the right of 4 until the other dimension (3) of the original is reached. Then at the intersection of the columns will be found the desired dimension—namely, $1\frac{1}{2}$, so that the 4 in. $\times$ 3 in. print will reduce to $2\frac{1}{2}$ in. $\times$ $1\frac{1}{2}$ in., as can be proved by the rule of proportion previously given.

REDUCTION, MECHANICAL

This includes the method of slightly reducing density by expansion of the film (see "Enlarging by Stripping"), and also those methods described under the heading "Reducing Negatives by Mechanical Means."

REFLECTED LIGHT

Light which does not reach the object direct, but which is reflected thereon. The table given under the heading "Light, Absorption and Reflection of," shows the amount of light reflected from various substances as compared with that which falls upon their surfaces.

REFLECTING SCREEN

A reflector, usually of white material, and used in portraiture. (See also "Reflectors for Portraiture.")

REFLECTION (See "Mirror Photography.")

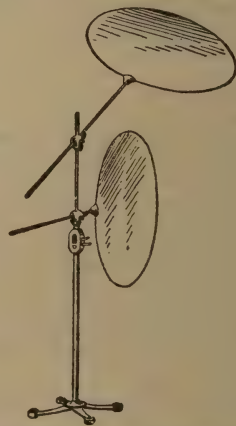
REFLECTIONS IN CAMERA

Unless a circular plate is used, and the camera is so designed that all rays from the lens reach the plate without obstruction, a certain amount of reflection will be caused by light striking the bellows or the internal woodwork. The bellows should be coated with a dead black to minimise those reflections that are unavoidable, and it should not be allowed to get shiny. Reflections are almost certain to occur when using a lens capable of covering a larger plate than the size for which the camera is intended. The superfluous light all round the image falls upon the surrounding bellows and woodwork, and is reflected and re-reflected from one part to the other—sometimes even to the lens and back again. Much of the reflected light is absorbed by the dead black or trapped by the folds of the bellows, but what escapes tends to fog or degrade the brilliancy of the negatives. Reflections may be caused also by brasswork, such as portions of the lens tube or diaphragm, from which the black has worn off. When such places are noticed they should be re-blackened. Where reflection is suspected, remove the focusing screen and place the eyes at the back of the camera, covering the latter and the head with a cloth to exclude all light but that coming through the lens. After a few seconds, to get accustomed to the comparative gloom, a fairly good idea may be obtained whether or not the fault is present to any detrimental extent.

REFLECTOR CAMERA (See "Reflex Camera.")

REFLECTORS FOR PORTRAITURE (Fr., *Écran d'éclairage, Réflecteur*; Ger., *Beleuchtungsschirm, Reflektorschirm*)

White or light-coloured screens used to prevent heavy shadows on the sitter's face at the side



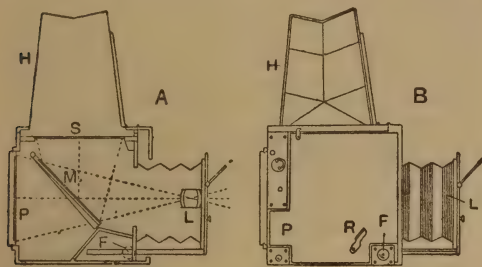
Studio Reflector with Head Screen

farthest from the light. They usually consist of canvas, calico, muslin, or other suitable fabric stretched on a frame supported by feet or by a stand, and having provision for adjustment at any desired angle. A typical studio reflector with a head screen above it is here illustrated. A pure white reflector is seldom desirable, cream

or very light grey being preferable. For some special purposes, though very rarely, mirrors are used. The principle involved in the employment of reflectors is explained under the heading "Portraiture."

REFLEX CAMERA (Fr., *Chambre miroir*; Ger., *Spiegel-reflex Kamera*)

Synonym, reflector camera. A camera in which the image is focused on a horizontal ground glass screen by the aid of a surface-silvered mirror inclined at an angle of 45°, the latter being automatically swung out of the



Typical Reflex Camera

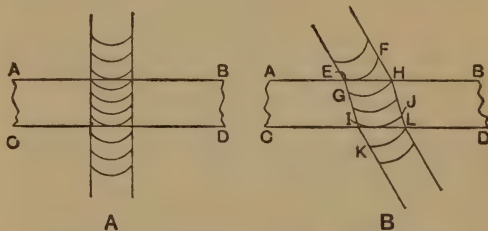
way when exposing the plate. The reflector principle was suggested very many years ago (see "Camera" and "Camera Obscura"), but it is only of recent years that the mechanical perfection of the reflex hand camera has been achieved. A and B show respectively the exterior and interior of a typical reflex camera, the lettering being the same in both; M is the hinged mirror, L the lens, S the horizontal focusing screen, H the hood shielding the last-named from extraneous light, F the focusing pinion, R the release that operates both shutter and mirror, and P the position of the plate. The dotted lines show the manner in which the image is reflected to the screen. The hood folds down flat when not in use. In designing these cameras great care has to be taken to secure identity of focus on the screen and at the position of the plate. The mirror is usually arranged to swing upward by means of springs or levers directly the shutter release is pressed, and to resume its former position after the exposure. In the majority of reflex cameras a focal-plane shutter is fitted. The advantages of the reflector principle are that a full-size image is seen, and may be accurately followed or focused up to the very moment of exposure, using if desired, and seeing the effect of, the rising or swing front, or any other adjustment. Large aperture lenses and lenses of long focus may also be used on near objects without stopping-down, as may frequently be necessary in press work, whereas with an ordinary hand camera it would be next to impossible to secure sharp focus by scale under such conditions.

Another form of reflex camera, but with a fixed mirror, is the twin-lens camera.

REFRACTION

When a ray of light falls upon any transparent medium it may be reflected, or it may pass through it, but in the latter case the waves of

light are retarded in their passage, exactly in the same way as the wind is retarded in passing through a clump of thick trees. Take first a sheet of glass, shown in section by A, B, C, D in diagram A, on which falls a beam of parallel light, the successive positions of the wave front being represented by the transverse curves. On meeting the glass at right angles to the surface, A B, there is a slight retardation, but as practically the whole of the wave front meets the glass simultaneously the relative positions remain the same and the direction of the ray is unaltered, although there is retardation in the glass, as shown by the curves being closer. If the beam strikes the glass at an angle, it is obvious that



Diagrams illustrating Cause of Refraction

part of the wave front strikes the glass before the other; thus, as in diagram B, the point E will strike the glass before the point F; as the wave is retarded in the denser medium, E moves to G, whilst F is moving to H; therefore, the wave swings round slightly, or, as it is termed, is refracted. Again, after passing through the glass, I will meet the rarer medium, air, before J, and will, therefore, have moved to K before J has reached L, and once more the ray swings round. Now, take only one surface of the glass, A B, as in diagram C, A B, and let L be the ray incident at the point D, which is refracted to E; then, with D as centre, describe the circle. Draw the normal C, D, F at right angles to the surface, A B, and from the point where the circle cuts the incident and refracted rays, I and E, draw the dotted lines L, M and E, N. Now it is obvious that the angle L, D, M is greater than E, D, N; the sine of the angle of incidence, L, D, C, or sine $i = \frac{L, M}{L, D}$, and the sine of the angle of refraction

or sine $r = \frac{E, N}{D, E}$ and the index of refraction is $\frac{\text{sine } i}{\text{sine } r}$; but it has just been shown that

$$\text{sine } i = \frac{L, M}{L, D} \text{ and } \text{sine } r = \frac{E, N}{D, E}$$

$$\therefore \text{sine } i = \frac{L, M}{L, D} \text{ and } \text{sine } r = \frac{E, N}{D, E}$$

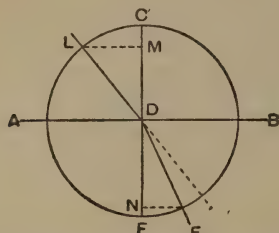
but L, D and D, E are radii of the same circle, and, therefore, are equal to one another

$$\therefore \frac{L, M}{L, D} = \frac{L, M}{E, N}, \text{ which is the index of refraction; this is generally measured for the D line (mean } \lambda \text{ 5,893), and is denoted by the symbol } \mu.$$

Suppose in diagram C L, M is 2 in. and E, N is 1.25 in.; then

$$\frac{L, M}{E, N} = \frac{2}{1.25} = 1.6$$

which would be the index of refraction for this particular glass. The index of refraction is



C. Diagram Showing How Index of Refraction is Found

practically the ratio of the velocity of light in one medium to the velocity in another medium. In general, this refers to the velocity in the given medium and in air, though the absolute index of refraction is obtained when the medium is in a vacuum.

REFRACTIVE INDICES (See "Refraction.")

REFRANGIBILITY

The quality or property of being refracted. (See "Refraction.")

REGISTER (Fr., *Registre*; Ger., *Register*)

A term employed to denote complete agreement between the position of the ground glass focusing screen and that of the plate in the dark-slide, without which the negatives will not be in focus. Lack of register between the dark-slides and focusing screen is seldom met with in good modern apparatus. To test the register of a suspected slide, focus sharply, then take a piece of ground glass the size of the plate, place it in the dark-slide ground side outward, and insert the slide in the camera with both shutters drawn and the separator removed. The ground glass should be pressed close to the front of the slide with the fingers, when if the image is still in sharp focus that side of the slide may be assumed to be in register.

REGISTRATION OF PHOTOGRAPHS (See "Copyright.")

RE-HALOGENISATION

A method of converting into a haloid salt the silver which forms the image of a negative, and then, by re-development, obtaining a negative of, if required, reduced density compared with the original. One of the most simple and satisfactory formulæ is:

Potassium ferricyanide	80 grs.	18 g.
Potassium bromide	120 "	27 "
Water	10 oz.	1,000 ccs.

The negative is immersed in this solution until the image is thoroughly bleached, as in mercurial intensification, and then well washed for about twenty minutes. It is now ready for re-develop-

ment. Any developer may be used. The plate must be exposed to light after bleaching; but exposure during the washing will be found sufficient. If the negative is fully re-developed, the re-halogenised plate will be practically unchanged from its original character. But shorter development will naturally convert only a portion of the haloid salt into metallic silver, thereby producing a negative possessing less density than the original. It is somewhat difficult to judge the degree of strength produced, although the development is carried out in white light; the unchanged haloid adds so much to the apparent strength in the early stages of development. The time will assist in judging the proportion of the silver salt developed into metallic silver; the full time would be the same as that originally occupied in development. After re-development, fixing is necessary in the same manner as with an ordinary negative.

The only change that can be effected by this method of working is reduction of density, and this takes place uniformly throughout the scale. The re-halogenised plate may be afterwards intensified or reduced by any other method.

REHNERT'S PAPER

Particulars of producing this sensitive paper for enlargements were published, it is believed, by Rehnert, in 1897. Rives paper is immersed in a solution of magnesium iodide, 2 parts; magnesium chloride, 1 part; alcohol, 100 parts; and when dry sensitised by floating until white on a 1 in 12 solution of silver nitrate, strongly acidulated with acetic acid. It should be exposed while wet, developed in a 1 in 200 solution of pyro, fixed in "hypo," and washed. If more brilliant results are wanted, the paper should first be sized with starch before sensitising.

REJLANDER, OSCAR G.

Born in Sweden, 1803; died in London, 1875. Began photography in 1853, and practised at Wolverhampton for many years. He was the first to use a number of negatives in the production of one picture, and to photograph the nude. His first combination picture (1855) was from three negatives. In 1857 he sent "The Two Ways of Life" to the Manchester Exhibition of that year; thirty negatives were employed in printing it, each being laid in turn upon the sensitive paper and exposed, while the rest of the paper was covered with black velvet. He was one of the first to use photography for the purpose of book illustration, his illustrations to Charles Darwin's book, "The Expression of the Emotions," being, perhaps, the best known.

RELIEF, GELATINE (See "Gelatine Reliefs.")

RELIEF, PHOTOGRAPHS IN

In the many processes of making photographs in relief, the well-known property of chromated gelatine losing its water-absorptive power after exposure to light is taken advantage of. Negatives having over-strong contrasts give the most satisfactory results; in producing such a negative, the background should be black and the sitter's face and hair powdered, and lighted in such a way that the head stands out in the greatest possible contrast to the background.

The negative is printed upon a plate prepared as follows: Mix together 2 oz. of gelatine, 1 oz. of gum arabic, 10 oz. of water and 48 mins. of glacial acetic acid, and melt by the application of heat. Pour a quantity on a bevelled sheet of glass to the thickness of two or three millimetres, and let it set and dry in a horizontal position. The plate is sensitised by immersing it for a few minutes in a 3 per cent. solution of ammonium bichromate, with an excess of ammonia, and dried in the dark. The plate requires a longer exposure than if bichromate alone is used, from a quarter to half an hour being required in full sunlight, the printing frame being so placed that the sun's rays fall upon it as perpendicularly as possible. After printing, in which a certain amount of guesswork is necessary, the prepared plate is taken from the frame and placed in a 2 per cent. solution of alum to which a 2 per cent. solution of citric acid has been added. After soaking for several hours considerable relief is obtained, which is suitable for casting in plaster-of-paris, or, after dusting with graphite, can be electrotyped. In the latter case, varnish the edges of the relief plate before or after printing, so as to prevent the film from stripping when it is in the acid sulphate of copper bath. (See also "Acrograph," "Cameo," "Bas-reliefs," "Electro-phototypy," "Galvanography," "Photographic," "Gelatine Reliefs," "Photo-lithophane," "Photopolygraphy," "Photo-sculpture," "Plaster Casts from Photo Reliefs," "Woodburytype," etc.)

RELIEVO

A type of photograph invented in 1857 by Thos. C. Lawrence, of Greenwich. The sitter, in monochrome, or slightly tinted, stands out in a kind of stereoscopic effect against a coloured hand-painted background. A wet collodion plate is made in the usual way, and when dry the whole of the photographic background is scraped away. A suitable landscape or other background is then painted in by hand on white card, which is bound up not quite in contact with the photograph proper and then suitably framed.

REMBRANDT EFFECTS

So named after the painter Rembrandt, who lighted his portraits in a characteristic manner. Almost any shadow portrait is now said to be in the Rembrandt style. The sitter is so arranged that the chief light comes from behind, rendering most of the picture in shadow, which, however, must not be so intense as to lose all detail. In ordinary rooms this lighting is fairly easy to obtain by placing the sitter between the camera and the window, but not in the same direct line; the window should be at the side and behind the sitter, so that it is out of the field of view of the lens. A reflector is often needed to show up details in the shadows. By far the best effects are obtainable in the studio, by screening off all front light; especially must care be taken to shade the lens so that no direct light enters it, as otherwise fogging of the picture will ensue. This style of lighting is very favourable for photographs of ladies having an extra fullness of the chin and neck, as owing to the face being mostly in shadow such fullness is not so noticeable.

REMBRANDT PROCESS

An adaptation of the photogravure process to rotary mechanical printing, invented by Karl Klic, and worked in England since about 1895 by a Lancaster firm. The details of their method have been kept secret, but it is assumed that a print on carbon tissue is made under a transparency in the usual way, except that, either before or after the print of a picture is made, the tissue is exposed under a negative line screen—that is, a screen with transparent lines, instead of the network of black lines used in the half-tone process. The printed tissue is squeezed on to a copper cylinder, and there developed with hot water as in the carbon process. After being dried, the image is etched through by means of ferric perchloride, as in the ordinary photogravure process, the cylinder being rotated in the bath, and solutions of different strengths being used. On the resist being cleaned off, the copper cylinder is seen to have on it an intaglio etching which varies in depth, being deepest in the shadows. The image is cut up by thin lines formed by the screen, and the square spaces between the lines serve to hold the ink better than would the grain of the ordinary photogravure plate. The cylinder is mounted in a machine similar to that used by wall-paper or calico printers. Above the copper printing cylinder is the impression cylinder, covered with an endless blanket, and below the printing cylinder is an inking roller running in a trough of thin ink. A steel knife-edge presses against the printing cylinder and wipes off the ink from the surface, whilst leaving the ink in the hollows of the engraving. Paper in a long band is drawn from a reel through the machine, passing between the printing and impression cylinders, and thereby being printed. After leaving the machine, the paper is led off to a drying-room, where it is suspended in festoons, or it is rewound on another reel, or it may pass straightway into a cutting machine.

Recently the process has been developed into colour printing under the name of mezzochrome, and some very fine results have been produced. Whether the foregoing correctly describes the Rembrandt process or not, it is known that several other firms have imitated the results in this way, notably Bruckmann in Munich, Löwy in Vienna, and Saalburg in America. The process is also known under the name of mezzotintogravure, altogravure, Similiheliogravure, and Vandyck-gravure.

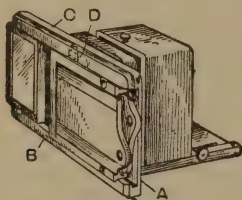
REPAIRING APPARATUS

Owing to a fall, or similar accident, cameras and other apparatus sometimes call for repair. If the damage is serious, it is best to send the apparatus to the manufacturer, or to a photographic dealer who undertakes repairs; but there are many trifling injuries within the power of the amateur worker to rectify. The most useful tools are a sharp penknife, a fretsaw, and a small, thin screwdriver, together with some good quality glue. When portions of woodwork come asunder a little thin hot glue is usually all that is necessary, applied very sparingly, and left until thoroughly set. Lost screws, if small, can generally be matched at any ironmonger's, but milled-head screws and special

brass fittings need to be ordered of a photographic dealer. Pieces of woodwork chipped off can frequently be matched by cigar-box wood, cut carefully to shape, glass-papered, and glued on, treating the part, when the glue has set, with a little water-colour paint to match the tone of the camera, and then rubbing on a trace of ordinary negative varnish with a rag, or a little French polish if handy. Ground glass can be purchased cut to size to replace a broken focusing screen.

REPEATING BACK (Fr., *Chariot multiplicateur*; Ger., *Multiplikator*)

An arrangement enabling two, or a larger number, of photographs to be obtained on the same plate. It is made in many different patterns, some of them being extremely ingenious. The illustration shows a simple type, for obtaining two cartes-de-visite on a half-plate. A is a



Repeating Back

panel attached to the back of the camera, having an aperture the size of the required picture, and furnished with grooved rails B and C for the dark-slide or the focusing screen. At D is a spring bolt, engaging in either of two slots in the edge of the dark-slide, these being so placed as to bring either half of the plate alternately into position against the opening in the panel. The photographs are, of course, taken separately.

REPTILES, PHOTOGRAPHY OF

The most useful camera for photographing reptiles is a reflex, fitted with as silent a release as possible, and a lens of fairly long focus. Snakes and lizards, toads, frogs, and tortoises are all more or less shy creatures, easily alarmed (the first-named are easily angered), so that some amount of caution and patience is necessary. When startled, a snake generally retreats, but should it find escape difficult or impossible, it may turn and strike at its pursuer; and this is more particularly the case with poisonous snakes. Therefore a long focus lens which will enable one to obtain a fair-sized image on the photographic plate, without approaching too close, will be found an advantage in many ways.

The wall and sand lizards at their play, or capturing the insects upon which they feed, make most charming and interesting subjects for photography, but on account of their extremely rapid movements and shyness, present many difficulties. Tortoises are particularly exasperating models at times, either shutting themselves up tightly in their shells or marching off in such a hurry that it is impossible to get a satisfactory pose. The best chances of success are when the tortoise first awakens in the morning, before the sun has had time to warm

him thoroughly; when he is busy feeding; or in the afternoon when he is about to go to sleep.

Frogs are best photographed in an aquarium with rocks placed on the bottom so that they can sit with their head and shoulders out of the water—a very favourite position in their natural state. In the spring of the year they may often be photographed sitting on the banks of shallow ponds and ditches. A few weeks later in the season they will not be so easily found, while masses of their spawn will be seen floating in the shallow water. The life history of the tadpole can be easily watched and photographed by placing some of the spawn in an aquarium, and keeping it in a cool place.

Toads are not nearly so difficult to handle or photograph as are the frogs. They are much bolder, and soon become quite tame if regularly supplied with worms, caterpillars, or meal-worms. The toad has very considerable character, and therefore always makes an interesting model.

Orthochromatic plates should always be used for photographing reptiles, and as full an exposure as possible given, so that a negative with a long scale of gradation may be obtained. It is rarely necessary to use a compensating filter, except in such cases as the chameleon, when the gradual changes of colour and re-arrangement of spots and bands of colour may be brought into greater contrast by the use of a suitable screen.

F. M.-D.

RESIDUES (Fr., *Résidus*; Ger., *Rückstände*)

The collection of residues, from the amateur's point of view, is hardly worth the trouble unless he uses a very large quantity of material, though probably about 60 to 70 per cent. of the total sensitive salts are not used in the formation of the actual images. Residues may be divided into four kinds: (1) emulsion residues, (2) fixing bath residues, (3) gold residues, and (4) platinum residues.

(1) *Emulsion residues*.—The general method of collecting spoilt emulsions, etc., is to mix them with plenty of water acidulated with impure nitric or hydrochloric acid, and boil till the setting property of the gelatine is destroyed. The sensitive salts settle to the bottom of the vessel in time, allowing of the decanting or syphoning off of the supernatant fluid; then the silver salts are collected and dried.

(2) *Fixing bath residues*.—The fixing baths both from negative and positive work should be saved and mixed together, and when a sufficient quantity is obtained they may be mixed with a saturated solution of liver of sulphur, which precipitates the silver as sulphide. This process should be done outdoors, as sulphuretted hydrogen is evolved, which is not only evil-smelling but is detrimental to any sensitive surfaces. A better method is to add zinc filings or magnesium powder, which decompose the silver hyposulphites with the precipitation of metallic silver.

(3) *Gold residues*.—Spent toning and combined toning and fixing baths should be acidulated with hydrochloric acid, and then an acidulated saturated solution of ferrous sulphate added till a precipitate is no longer caused.

(4) *Platinum residues*.—The developer and

first washing water of platinotype should be collected and preferably boiled down to a smaller bulk, a saturated solution of ferrous oxalate added, afterwards boiling.

The various precipitates may be collected and all the silver ones mixed, but the gold and platinum should be kept separate, and they can then be sent to the refiners, who will allow the market value of the metals less a small percentage for smelting.

Paper clippings of all kinds should be burnt and the ashes added to the general residues.

Silver is obtained from the residues by fusing with borax, charcoal, etc.

RESIN DRY PROCESS (Fr., *Procédé résine*; Ger., *Harz Prozess*)

An early dry collodion process, due to the Abbé Pujol, in which resin was used as a preservative. In each ounce of bromo-iodised collodion half a grain of ordinary resin was dissolved. The plate was then coated, sensitised, and washed, being ready for use when dry.

RESINISED PAPER (Fr., *Papier résiné*; Ger., *Harzemulsionspapier*)

The use of resin for photographic paper was first suggested in 1863, and the method adopted was to make an alcoholic solution of resins with a chloride and brush this over the paper or immerse the latter in the solution, dry, and sensitise subsequently by floating on a solution of silver nitrate. Three years later an aqueous solution of shellac in borax or sodium phosphate was used. Later still, Cooper suggested the emulsification of bleached shellac in gelatine. In 1891, Valenta suggested the following method of working, which gives excellent matt surface prints:—

Hard gelatine . . . 350 grs. 80 g.

Soak in water for half an hour and drain well.

Pale French resin . . . 350 grs. 80 g.

Liquor ammonia . . . q.s. q.s.

Distilled water . . . 10 oz. 1,000 ccs.

Powder the resin, rub up with the ammonia and a little water, add the rest of the water, boil, and add ammonia from time to time till a clear solution is obtained. Add the gelatine, stir till dissolved, and add—

Ammonium chloride . . . 88 grs. 20 g.

and filter. Finally add enough saturated solution of citric acid to give a strong acid reaction. The acid precipitates the resin as an impalpable powder, which is suspended in the gelatine. The paper should be brushed over with the solution and then floated on the surface for three minutes and dried, and then sensitised in the usual way by floating.

A variant was suggested by E. J. Wall, and consisted in the use of an ammoniacal alcoholic solution of resin, which was added to an ordinary gelatino-chloride print-out emulsion. These papers are particularly suitable for platinum toning, and give fine black tones.

RESINS (See "Gums and Resins.")

RESORCIN (Fr., *Résorcine*; Ger., *Resorcin*)

Synonyms, resorcinol, metadihydroxybenzene, $C_6H_4(OH)_2$. Molecular weight, 110. Solu-

bilities, 1 in '6 water, 1 in '5 alcohol, soluble in ether. It is in the form of white prismatic crystals obtained by the action of caustic soda on sodium dibenzene sulphonate. It has the same formula as hydroquinone, but the hydroxyl groups $(OH)_2$ are attached at different points to the benzene ring, and it has no developing power. It has been used as an addition to emulsions without excess of silver nitrate to obtain vigour in printed-out images.

RESORCINPHTHALEÏN

A synonym for fluoresceïn.

RESTORING NEGATIVES (See "Broken Negatives," "Cracked Negatives," "Cracks in Varnish," "Scratches on Negatives," etc.)

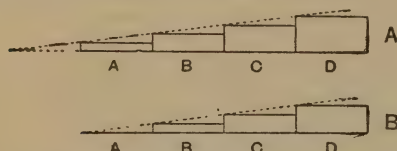
RESTORING PHOTOGRAPHS (See "Faded Negatives and Prints, Restoring.")

RESTRAINER (Fr., *Modérateur*; Ger., *Zurückhalter*)

Any compound which will check the too energetic action of a developer. The most popular restrainer for alkaline developers is a soluble bromide, which works well with the caustic alkalis, and in some cases with the carbonates. When the alkali is ammonia, ammonium bromide may be used; otherwise, potassium bromide may be employed. Bromide has more effect in restraining the least exposed portions of a negative—that is, the shadows—than on the better lighted portions, and as a result it gives greater contrast and brilliancy. In cases of over-exposure, where normally a flat and lifeless negative would be the result, this property of bromide is turned to account, the addition of a very few drops of a 10 per cent. solution to the developer often sufficing to save an under-exposed plate. The generally accepted theory is that the bromide forms a double compound with the silver salt in the film, and that this double compound is less readily acted upon by the developer. With stale plates, a restrainer is absolutely necessary, as the silver salts in the film seem to undergo a certain amount of decomposition, and reduction (development) takes place where the light has not acted. Bromide is also necessary with bromide and gaslight papers, as it serves to keep the white parts of the print clear while the image is being developed to its proper density.

Some authorities recommend the omission of a restrainer from the developer entirely, while others advise its use with extreme caution. Watkins, for example, says that the use of a restrainer, such as potassium bromide, is a legacy left from the early days of pyro development, that its use introduces complication and variation from the usual simple course of development, without sufficient compensation, and that with a good modern dry plate and sodium carbonate as the alkali, the restrainer is best omitted from the normal developer and used only exceptionally to "hold back" the lowest tones or fog. Watkins illustrates this "holding-back" power with two diagrams, A and B, the former representing four steps of gradation, A, B, C, and D, produced by, say, five minutes

development without bromide. **B** gives an idea of the result of the same exposure if the same developer, with a little bromide added, is used for the same length of time. The steepness of gradation (and therefore the contrast in the print) is identical in the two cases; but the bromide has retarded all the tones and prevented the lowest one, **A**, from appearing at all. It has, in fact, at this stage reduced the speed of the plate. If development with bromide were continued, the tone **A** would develop out, and in due time take exactly the same place as if no bromide were used. To utilise the restraining power of a bromide, therefore, development must be terminated while the holding-back power is still in force. Watkins also points out that with high factor developers the lower tones come out so early in development, they rush up, so to speak, that the holding-back power of bromide is exhausted before a useful degree of contrast is attained, and bromide is of very little



"Holding Back" Power of Restrainer

use with this class. But if a low factor developer is used, the tones naturally come out very late in development, and the bromide decidedly alters results. It is with a low factor developer and plenty of bromide that gross over-exposure can be made to give good negatives. But when once the tones have appeared it is quite useless to add a bromide with the idea of holding back fog or the lower tones. With high factor numbers, bromide has practically little result, except to make development slower.

The only restrainers that are of any service when development has once started are the citrates (*which see*); they stop the shadows and allow the high lights to go on developing.

The usual dose of potassium bromide is 5 drops per ounce of mixed developer; and, of course, the ammonium and sodium bromides may be used in a like manner. Potassium bromide is bulk for bulk the weakest restrainer; ammonium bromide the strongest; and sodium bromide the medium, the most suitable proportions being potassium 120, sodium 103, and ammonium 98.

RETARDATION

A restraining of development by the addition of a restrainer.

RETARDER

A synonym for restrainer. The addition of plain water and the chilling of the developer are the simplest retarders.

RETICULATION

Peculiar wavy markings in relief which are common to colloids; they sometimes appear on gelatine negatives. In some photo-mechanical processes reticulation is purposely brought about, but it often occurs when not wanted and

ruins the negative, there being no known cure for it. It appears mostly during intensification with mercury, and is thought to be due to the use of a too strong mercury solution which tans the film; this, when placed in ammonia for blackening, breaks up into pinholes or forms ridges.

In process work, the reticulation of the gelatine film is the basis of several photo-mechanical processes—namely, Poitevin's photo-lithographic process, the Pretsch process, the collotype process, Dallas process, papyrotint, and numerous others. It is believed that the reticulation of the film is due to unequal contraction, due to the various parts being variably acted upon by light according to the depth of the tones of the picture. It has been noticed that on the collotype plate the grain or reticulation occurs just at the last moments of drying. Reticulation is also promoted by the addition of chemical substances, usually of an astringent nature, to the film, and in this case the reticulation is probably due to a tanning action influenced by the action of light.

RETOUCHER, AUTOMATIC

A retouching pencil or holder in which the lead is made to move rapidly up and down by an electric current, so that a fine stipple is obtained on portrait negatives in a shorter time than if applied by hand alone. The guidance of a skilled retoucher is, however, still necessary; the automatic pencil merely facilitates work—it does not supply the place of artistic discrimination.

RETOUCHING

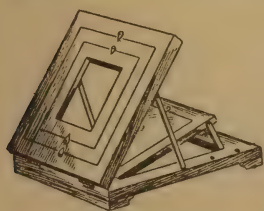
The working up of negatives and prints by hand. In this article only the retouching of negatives will be considered. For prints, *see* "Working-up Prints."

It is rarely desirable to retouch a landscape negative, but portrait negatives are commonly retouched by professional workers. The easiest way of improving portrait negatives in a small degree is to coat the glass side with matt varnish, and then, when dry, work on it lightly with a lead pencil or a stump and powdered blacklead. The parts covered with lead pencil print lighter. This work is, however, not true retouching, and will serve only for remedying broad patches in the negative.

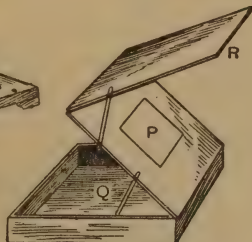
For retouching proper, a retouching desk, pencils, and a bottle of medium will be required. Retouching desks (*see* A) may be bought ready made, or may easily be converted from an ordinary box, as shown at B. A hole, **P**, is cut with a rebate in the lid to hold the negative, and the lid fixed at a convenient working angle by means of narrow strips of wood, **Q**, at each side. An extra piece of wood, **R**, is fixed to the top in order to shield the light from the surface of the negative. All the light must come through the negative, and it is advisable to place white paper in the bottom of the box.

The worker should experiment with three retouching pencils—hard, medium, and soft; and they should have a point literally as sharp as a needle, to obtain which very fine glass-paper or emery cloth is used. Place a piece flat on a table, take the pencil between the thumb and fingers, and carefully roll the point round and round on

the rough surface until the lead tapers to a fine point. Retouching medium may be bought, or it may be made according to one of the following formulæ: No. 1.—Turpentine, 2 oz.; powdered resin, 60 grs. No. 2.—Sandarach, 80 grs.; alcohol,



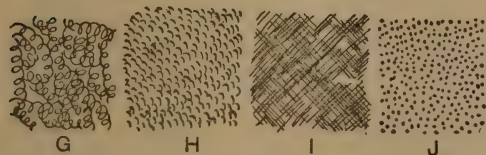
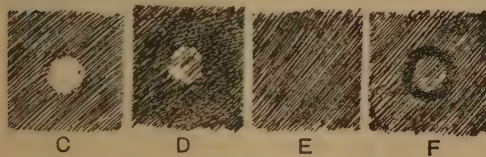
A. Retouching Desk of Modern Design



B. Home-made Retouching Desk

1 oz.; castor oil, $1\frac{1}{2}$ oz.; venice turpentine, 40 drops.

The majority of beginners have an erroneous idea of retouching, hence their failures. The secret is not to attempt too much at first, but to be satisfied if even only one freckle or wrinkle has been removed. Now the general idea is that the whole of the negative—or, rather, the face—is worked on by the retoucher with his pencil, which is wrong. Only the blemishes require to be worked on, so as to bring such clear spots up to the density of the surrounding parts; diagrams C and D explain this. C represents in a highly magnified form a spot or freckle on a negative which is to be worked out, the blemish appearing as a clear spot in an almost opaque part of the negative. If the pencil is worked, and the lead is put in in even quantities all over the face, the opaque surroundings would be even more dense, and the spot would contain only as much lead as the dense parts; therefore the spot would still show, say, as in D. The correct thing



The Retoucher's Various Strokes and Touches

to do is to leave the surrounding parts alone for the time being, and to work the pencil only on the blemishes, putting sufficient lead in them to bring them up to the required density. The result, if carefully and properly done, would then be as shown at E, that is, a perfectly even surface.

It is advisable to take a rough print of the

negative to be retouched on glossy paper, which will show up the defects and serve as a guide to the work. Dust the negative, put a drop of retouching medium on the film side, and then, with the finger-tip, rub the drop of medium in a circular motion over the whole of the face to be retouched; continue rubbing gently until the surface feels "tacky," and put the negative on one side to dry. Place the negative film side upwards over the hole in the retouching desk, so that a good light comes through it, and, having sharpened the pencil, begin filling up the clear holes, taking particular care that the lead does not go on the outside of the hole, or the result will be as at F. The particular "stroke" or movement of the pencil needs consideration. The four most used strokes are shown, G to J; G is known as the scribbling touch, and is most useful for softening up and bringing together high lights and shadows, such as the lines under the eyes and down the nose; H is a "comma" touch suitable for large freckles and blemishes; I is the "cross hatch" used for filling up comparatively large spaces; and the "dot" J is the most useful touch of all for filling up freckles.

Begin, then, by dotting the smaller freckles and continually take rough prints to note the progress of the work. Be particularly careful not to do too much or to lay on the lead too thickly, or the working will show. When the freckles and other blemishes are dotted out, smooth the rough skin, soften the wrinkles and places where shadows meet the high lights with the scribbling touch G. This is all a beginner should attempt for some time, and even this requires considerable practice and care to do properly. Work done roughly and unsuitably can easily be rubbed off with a clean rag wetted with the retouching medium, and a fresh start made.

Negatives are also retouched with the knife. (See "Knife, Retouching.")

RETOUCHING, CHEMICAL (Fr., *Retouche chimique*; Ger., *Chemische Retoucher*)

Modifying or removing portions of a photograph, usually in the negative, by means of chemical solutions applied with a brush. Thus in developing, any details that come up too rapidly may be kept back by draining the negative and painting the parts with a 5 per cent. solution of potassium bromide, afterwards returning the plate to the dish and completing the development. To reduce harsh lights or dense portions, or to introduce clouds or shadows in a finished negative, a solution of ammonium persulphate (10 to 20 grs. to 1 oz. of water) may be employed, placing the negative after reduction in a 5 per cent. solution of sodium sulphite for a few minutes before washing. An alternative is to use Farmer's ferricyanide and hypo reducer (see "Reducing Negatives, etc."). To obtain a local increase of density, to insert high lights, to strengthen thin portions, etc., a solution of mercuric chloride or other intensifier may be used. The negative, after washing, is pressed with blotting-paper to remove the excess of moisture, and is supported on a retouching desk, as nearly horizontal as possible; the solutions, which should not be too strong, are applied quickly with a brush, and the negative washed directly the desired result is obtained.

Negatives are also improved by the use of dyes, etc. Stain matt varnish with aniline dye, red, green, or yellow being suitable. Flow the varnish over the glass side of the negative. Place the negative in a frame film (not varnish) side outwards, and expose to strong sunlight for some days or until the dye has partially faded, when the negative will give brighter and better prints. This is really a dye process of intensification. The light going through the outward film to the dye beneath naturally causes it to fade, the amount of fading being governed by the density of the image.

REVERSAL, OR SOLARISATION (Fr. and Ger., *Solarisation*)

A phenomenon occurring as the result of extreme over-exposure, a positive instead of a negative image being produced on development. Abney has stated that preliminary exposure to diffused daylight, the use of a powerful developer, and the treatment of the plate with a solution of an oxidising agent before exposure, facilitate reversal; and, in his opinion, it can only be produced when there is atmospheric oxidation. The addition of thiocarbamide to a well-restrained developer will produce reversal, especially if hydroquinone or eikonogen is used.

REVERSED NEGATIVE (See "Negative, Reversed.")

REVERSING BACK

An adjustment whereby the back of the camera may be turned, in order to obtain either upright or horizontal pictures. Before the introduction of the reversing back the only way of doing this was to turn the whole apparatus on its side. The usual form of reversing back consists of a square wooden frame rebated on the inner side to fit closely in the camera, and having on the outer side suitable grooves to take the focusing screen or dark-slide. The corners of the frame are slightly recessed, two of them fitting under brass plates on the camera, while the other two are secured by turn catches. To reverse the back, the catches are unfastened, the frame lifted out, turned half-way round and re-inserted, being then re-fastened as before. An improved form, the revolving back (*which see*), does not need to be removed from the camera.

REVOLVER (See "Gun and Revolver Cameras.")

REVOLVING BACK (Fr., *Cadre de verre dépoli rotatif*; Ger., *Rotations Visirscheibe*)

An arrangement whereby the focusing screen or dark-slide may be changed from a vertical to a horizontal position, or vice versa, without removal from the camera. The frame carrying the rails or grooves to take the focusing screen or slide is attached to a circular turntable let into the camera back, and having ball catches to check it at the two positions. With such a movement it is possible to change from one position to another with scarcely a second's delay, even with the plate inserted and the shutter of the slide drawn. The one disadvantage of the revolving back is that the camera needs to be slightly larger.

RHODIUM TONING

A method of toning with salts of rhodium (a rare metal resembling palladium and, in a less degree, platinum), was advocated about 1890, in America, but it did not come into general use. A formula is:—

Rhodium and sodium

chloride . . .	22 grs.	5 g.
Acetic acid . . .	96 mins.	20 ccs
Water (distilled) . . .	10 oz.	1,000 "

The metallic silver of the prints slowly takes a yellowish-red colour which deepens in the fixing bath.

RIPENING

Photographic sensitive emulsions undergo a process known as ripening, as explained under the heading "Emulsion."

The term is also sometimes applied to toning baths; an acetate and gold toning bath, for example, is ripened by allowing it to stand for twenty-four hours or more before use, while the alum-"hypo" toning bath for bromides is ripened by adding a few pieces of torn waste silver prints.

RISING FRONT (Fr., *Décentrement vertical*; Ger., *Verschiebbares Objektivbrett*)

An adjustment enabling the lens to be raised or lowered with respect to the plate, in order to include more of the subject at the top or bottom of the picture. It usually consists of a panel carrying the lens and moving freely between two grooved upright posts. The sides of the posts are generally slotted, so that milled-head screws inserted in the panel may move up or down with it, and enable it to be clamped at any desired height. The rising front is, however, made in various forms, some modern high-grade cameras having even the luxury of a rack and pinion movement to the front. Frequently, the lens panel is separate from the front, upon which it slides in horizontal grooves, thus giving a "cross" adjustment as well as a rise and fall. The whole front is often made also to swing. (See "Swing Front.") A rising front is almost indispensable for practical work, but in using it care must be taken that the lens is not raised too far, otherwise the upper portion of the negative will be badly lit, or perhaps will show blank corners.

RIVES AND SAXE PAPERS

Specially pure raw papers, free from imperfections such as metallic particles, used for coating with sensitive emulsions. Both of them are Continental productions. Rives paper had its origin at Rives, France, and is thin and tough. Saxe paper had its origin at Saxe, Germany, and is thicker and heavier; sometimes it is referred to as "Steinbach" paper.

ROBINSON, HENRY PEACH

Born at Ludlow, 1830; died at Tunbridge Wells, 1901. He exhibited at the Royal Academy when twenty-one. He began business as a professional photographer at Leamington, in 1857, and later (1868) built a studio at Tunbridge Wells, where he practised until his retirement in 1888. He produced many "combination"

pictures, of which "Fading Away" (1858) and "Dawn and Sunset" (1885) were among the best known. The latter is reproduced as a plate to this work, and was awarded a medal by the (now) Royal Photographic Society. Three separate negatives were used, and the original measures 30 x 21 in. His most ambitious effort was "Bringing Home the May" (1863). He was Vice-President of the Photographic Society of Great Britain (now the Royal Photographic Society) in 1887; President of the Photographic Convention of the United Kingdom (Leeds Meeting), 1896. He was a writer on the art and business sides of photography, his best-known works being "Pictorial Effect in Photography" (1869), "Picture Making by Photography" (1884), "The Studio and What to Do in It," and "Letters on Landscape Photography."

The developer sometimes referred to as the Robinson pyro-ammonia developer is as follows:—

A. Pyrogallie acid	. 1 oz.	144 g.
Citric acid	. 40 grs.	12 "
Water	. 7½ oz.	1,000 ccs.
B. Potassium bromide	. 120 grs.	36 g.
Liquor ammoniæ ('880)	1 oz.	143 ccs.
Water	. 7 "	1,000 "

Take 3 oz. of water and add 1 dram each of A and B.

ROCHELLE SALTS (See "Potassium and Sodium Tartrate.")

ROCK AMMONIA (See "Ammonium Carbonate.")

ROCK CRYSTAL

A synonym for quartz.

ROCK SALT

An impure variety of common salt, which, chemically, is sodium chloride.

ROCKER

An appliance for automatically rocking the developing dish, so that the operator may leave the plate in it while attending to other matters. A simple form consists of a pivoted platform below which a weighted pendulum is attached. If set swinging by an occasional touch, this keeps in motion for some time. Many clockwork rocking devices have been invented.

ROCKING DISHES

Dishes containing photographic solutions require occasional rocking, otherwise the plate or prints may not be properly covered and the action of the solution is likely to be uneven, while air-bubbles and sediment have also a chance to settle in one place. But continual or excessive rocking is not necessary, and tends to cause frilling.

RODINAL

A one-solution developer consisting of a concentrated solution of para-amido-phenol ($C_6H_4OHNH_2$), introduced by Andresen; it needs only the addition of water to make a working solution. Formerly it was obtainable in powder form, under the name of "unal."

The following is one of the formulæ given by the *Chemische Zeitung* for making rodinal:—

Potass. metabisulphite or sodium sulphite	. 3 parts
Para-amido-phenol chlorohydrate	1 part
Sodium hydrate (sat. sol.)	. q.s.
Hot distilled water	. 10 parts

When the first two are dissolved in the water, a saturated solution of sodium hydrate (caustic soda) is added very gradually until the precipitate first formed is dissolved and the solution quite clear. Few photographers attempt to make it, however, as the commercial article is so cheap and good. It keeps well, darkening in colour with age. When diluted with water, however, it assumes a reddish tinge and gradually loses its developing powers, but if diluted with a 5 to 10 per cent. solution of pure sodium sulphite instead of water it will keep quite well. For normal exposures, use rodinal 1 part and water 20 parts. In cases of over-exposure, use less water, and add a few drops of a 10 per cent. solution of potassium bromide. In cases of under-exposure use from 30 to 40 parts of water. The more dilute the rodinal the softer will be the negative, and vice versa. When the extent of the exposure is not known, it is well to begin development with a 1 in 30 solution, and then, if necessary, to correct over-exposure by adding, drop by drop, a solution composed of 3 parts each of rodinal and water and 1 part of potassium bromide. The solution should be added to the developer in a measuring glass, and not direct into the developing dish. It is better, in a case of known over-exposure, to add the bromide to the developer before it is applied to the plate.

Many fail to get density with rodinal simply because they do not develop long enough. The image appears very quickly, and there is a temptation to remove at once the negative from the developer instead of giving time for density to be attained. Negatives developed with rodinal appear to lose much of their density during fixing.

For bromide and gaslight papers rodinal should be used in the proportion of 1 part to 20 to 30 parts of water, adding 2 drops of a 10 per cent. solution of potassium bromide to each ounce of developer. The tone or colour of the print varies according to the exposure and strength of the developer, strong solutions giving blue-black and weak solutions grey; with too little bromide the high lights may not be clear, while with too much bromide there will be greenish blacks. These remarks apply also to lantern plates. For stand development the strength usually employed is 1 part of rodinal to 100 to 200 parts of water. Rodinal may be mixed with other developers, as explained under the heading "Developers, Mixed or Combined."

ROLL FILMS (See "Cartridge Film" and "Film Manipulation.")

ROLLER BURNISHER (See "Burnisher.")

ROLLER SLIDE (Fr., *Chassis à rouleaux*; Ger., *Roll-cassette*)

A dark-slide specially designed for use with roll films. First suggested by Relaudin, in

1855, roller slides were constructed by Melhuish in 1856, Burnett in 1857, Audineau in 1862, and Warnerke in 1875. These were all for use with negative paper. It was, however, the Eastman Company in 1885 who rendered this form of slide really popular by the introduction of their roll-holder, which also was at first used with paper films. It consists of a box made to slide into the dark-slide grooves of the camera back, and having a draw shutter in front. Two rollers or spools are contained in the box, one holding the unexposed film, and the other furnished with an external winding key by means of which the film is wound off as exposed. Suitable means are adopted to keep the film taut and to indicate how far it is to be wound for each exposure. The spools are interchangeable.

ROLLER SQUEEGEE (See "Squeegee.")

ROLL-HOLDER (See "Roller Slide.")

ROLLING PRESS (Fr., *Presse à satiner à froid*; Ger., *Satinirmaschine*)

A machine for flattening and giving a glossy surface to mounted prints. It consists of a large flat steel plate moving under a single polished roller, or with the roller moving over the plate. The term is also applied to a machine having two rollers, one of which is nickelled.

ROLLING PRINTS

The passing of mounted prints through rollers, or between a roller and a steel plate, for the purpose of improving their appearance and making them lie flat. The process is often confused with that of burnishing, but is much more simple.

ROLLING-UP

The passing of an ink-charged roller over a lithographic stone for the purpose of strengthening the image. (See also "Photo-lithography.")

RÖNTGEN RAYS (See "X-ray Photography.")

ROSE BENGAL

Synonym, potassium tetra-iodo-chloro-fluor-escein. One of the eosine group, formerly used considerably for sensitising gelatine dry plates and collodion emulsion for yellow and green. It has been used alone, and also in combination with eosine. Soluble in water and alcohol. Von Hübl gives the absorption of rose Bengal as approximately 542 μ (middle) from 563 μ (maximum). This writer recommends, for the negative for the red print, adding to 100 ccs. of collodion emulsion 2 ccs. of the following dye mixture, and bathing the plate before exposure in $\frac{1}{2}$ per cent. silver nitrate solution:—

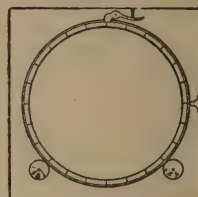
Eosine yellow (1:150)		
alcoholic sol.	90 mins.	30 ccs.
Rose Bengal (1:150)		
alcoholic sol.	30 "	10 "

A 1 in 500 solution of picric acid in water is used as a filter in a tank $\frac{1}{8}$ in. (5 mm.) thick, or a gelatine plate coloured with naphthol yellow G.

ROTARY SCREEN

For the three-colour half-tone process the ruled screen is preferably of circular form and mounted

in a rotating carrier, so that the ruling may be turned to a suitable angle for each colour. If the angles are not properly chosen the superimposing of the colours will cause a moiré pattern on the resulting print. The Levy rotary



Rotary Screen Carrier

screen, here illustrated, provides means of altering the angle with precision.

ROTARY SHUTTER (Fr., *Obturbateur rotatif*; Ger., *Dreh-verschluss*)

A shutter in which a circular disc with an aperture towards the side is caused to revolve across the lens by a coiled spring or similar means, the opening exposing the plate as it passes.

ROTATING BACK (See "Revolving Back.")

ROTATING STOPS (See "Diaphragms.")

ROTUNDITY

A quality usually associated with the images produced by lenses of large diameter and aperture which are believed by many practical portraitists to give an impression of plasticity and relief, almost approaching a stereoscopic effect.

ROTTENSTONE

A Derbyshire mineral, reduced to a fine powder and used for polishing metals. It was used for polishing daguerreotype plates.

ROUGE (Fr., *Rouge*; Ger., *Rot*)

Red oxide of iron, used for polishing metals and glass, including lenses. Process workers use the very finest jewellers' rouge for polishing the surface-silvered optical plane mirrors. The rouge should be thoroughly sifted, warmed, and broken up before applying.

ROUGHENING PRINTS

The roughening of prints to give them a matt surface is now rarely resorted to. The simplest method is to rub the surfaces gently with an abrading powder, such as finely powdered and sifted pumice stone or cuttle-fish bone. Another method is to squeeze the wet and glazed print down upon very finely ground glass or matt-surface celluloid, the surfaces of the medium selected and the prints themselves being treated in precisely the same way as for glazing. (See "Glossy Surfaces on Prints.")

ROUILLÉ-LADEVÈZE PRINTING

A pigment process for the production of permanent photographs, invented by Rouillé-Ladevèze, of Paris. Prepare two solutions: (A) 200 grs. of pure gum arabic in 1 oz. of water; (B) 30 grs. of ammonium bichromate in 1 oz.

of water. Mix together, filter through flannel, and add, say, 300 grs. of tube water-colour, the actual quantity depending upon the strength and quality of the colour. The paper is brushed over with the mixture in a weak yellow light, dried in the dark, printed under a negative (average time, 30 minutes), and developed by washing in water at about 80° F. (27° C.), which removes the gum not insolubilised by the action of light. The print is fixed on a sheet of glass by wooden clips, immersed in water, and moved to and fro until the image appears. Finally it is dried.

ROUNDNESS

That quality in a print, and strongly desirable in portraiture, which suggests proper modelling and relief. The chief means to this end are suitable lighting and the use of a large aperture.

ROUTING

In process work, a routing machine (first introduced by Royle) is used for the purpose of removing from the blocks the large spaces which are to print white. This can be done by etching, but is more quickly and efficiently done by the routing machine. There are two forms of these machines: one in which the cutter is stationary while the bed carrying the plate is moved, and the other in which the plate is fixed to the bed of the machine, whilst the cutter is mounted on an arm which can be moved radially with a kind of pantograph motion over any part of the plate. The cutters resemble fluted drills, and by moving the arm a channel the width of the cutter is made in any direction.

ROYAL PHOTOGRAPHIC SOCIETY

The premier photographic society, founded in 1853, under the title of "The Photographic Society of London," which, in 1874, was changed to "The Photographic Society of Great Britain," and in 1894 was further modified by Queen Victoria's commands to "The Royal Photographic Society of Great Britain." The objects for which the Society was established may be summarised in the phrase "the advancement of photography." Meetings for lectures, demonstrations, etc., are held at regular and frequent intervals, and the members have the use of a studio, dark-rooms, library, etc. A monthly *Journal* is published and exhibitions are held. Its first President was Sir Charles Eastlake, P.R.A. (1853 to 1855). The Society awards a "Progress" medal nearly every year in recognition of any important invention, research, or publication, the first to receive it being Captain W. de W. Abney (1878) for his scientific work in the advance of photography. The Fellowship (F.R.P.S.) is open only to those members who are able to satisfy the Council that they have ability in one or other of the many branches of photography; elections to the Fellowship take place twice a year. Photographic societies may, by the payment of one guinea per year, become affiliated with the Royal Photographic Society.

RUBBER SOLUTION (See "Indiarubber.")

RUBY GLASS

Glass "flashed" with ruby (red) colouring matter; that is, the colouring does not go right

through the glass, but the surface is coated with vitreous colouring matter. It is used as a screen or filter to stop the passage of actinic rays. The subject of "safe" light is gone into fully under the headings "Safe Light," "Bichromate Lamp," "Dark-room Illumination," etc.

RUBY LAMP (See "Dark-room Lamp.")

RUBY MEDIUM

A ruby or red fabric used in the place of ruby glass in the production of a "safe" light. Sunlight has a bleaching action upon it and pinholes are so easily caused that its use should be restricted to artificial light.

RUBY VARNISH

A varnish for application to windows, incandescent electric bulbs, etc., for dark-room use; it is inferior to ruby glass. Mix equal parts of ordinary white hard varnish and methylated spirit, and to every pint add $\frac{1}{4}$ oz. each of chrysoidine and coralline rouge, two aniline dyes; shake well, allow to stand for a day or two, and then, if all the dye is dissolved, add more. If the dye does not completely dissolve, use the clear solution.

RUSSIAN DEVELOPER

A developer of Russian origin, and introduced about 1889. It is said to give with dry plates negatives which cannot be distinguished from those yielded by wet plates. The formula is:

A. Sodium sulphite	. 150 grs.	34 g.
Pot. ferrocyanide	. 350 "	80 "
Sodium carbonate	. 350 "	80 "
Distilled water	. $3\frac{3}{4}$ oz.	375 ccs.
B. Pyro	. 75 grs.	17 g.
Ammonium chloride	. 75 "	17 "
Distilled water	. $1\frac{1}{2}$ oz.	150 ccs.
C. Trimethylamine	. 5 mins.	1 g.
Distilled water	. 95 "	22 "

To prepare the working developer, take of A, 300 mins.; B, 40 mins.; and C, 15 mins. More of C can be added if great density is desired.

RUSSIAN VIGNETTES (See "Black Vignettes.")

RUST SPOTS

Small black metallic spots which usually appear on gelatino-chloride papers (P.O.P.), and caused by particles of rust in the first washing water, the rust coming from water pipes, tanks, etc. They may be prevented by giving the prints (before toning) a bath of salt, soda and water:

Common salt	. . . 1 oz.	110 g.
Washing soda	. . . $\frac{1}{2}$ "	55 "
Water	. . . 10 "	1,000 ccs.

Immerse the prints for five or ten minutes, wash, tone, and fix. This bath is not suitable when platinum is employed for toning.

RYTOL

A "tabloid" developer, supplied with an accelerator, also in tabloid form. For dry plates and bromide papers one of each of the tabloids—Rytol and accelerator—is dissolved in 4 oz. of water; for gaslight papers and lantern slides (black tones) the water is reduced to $2\frac{1}{2}$ oz.

S

SAFE EDGE

The opaque edging on negatives necessary for carbon printing.

SAFE LIGHT (Fr., *Eclairage inactinique*; Ger., *Sicheres Licht für Dunkelzimmerbeleuchtung*)

A term applied to the light obtained with the use of coloured filters placed in front of the dark-room illuminant. The ordinary commercial coloured glass is rarely of any practical use, except for the manipulation of positive materials, and even for these specially made safe lights usually give greater safety combined with greater brilliancy. It is as well to divide them into the several classes—namely, for positive, ordinary, isochromatic and panchromatic plate work.

For positive work, such as lantern slide and bromide print making, the light may be of a bright orange or green colour, as these materials are not very sensitive.

Tartrazine or naphthol

yellow	. 200 grs.	20 g.
Rose Bengal or eosine	. 10 "	1 "
Distilled water to	. 20 oz.	1,000 ccs.
Gelatine	. 800 grs.	80 g.

Soak the gelatine in the water till soft, melt in a water bath, add the dyes, and when thoroughly dissolved, filter and coat, allowing 20 mins. per sq. in., or 20 ccs. for 100 qcm. of surface.

For a green light, the eosine or rose Bengal in the above formula may be replaced by the same quantity of naphthol green. For isochromatic plates, one sheet should be coated with:

Tartrazine	. 200 grs.	20 g.
Rose Bengal, or fast red	. 100 "	10 "
Gelatine	. 800 "	80 "
Distilled water to	. 20 oz.	1,000 ccs.

and another glass with:

Methyl violet	. 100 grs.	10 g.
Gelatine	. 800 "	80 "
Distilled water to	. 20 oz.	1,000 ccs.

This red screen transmits from the red to λ 5,900 in the yellow and the violet absorbs from λ 6,500 to λ 5,000, so that only the extreme red from λ 7,000 to λ 6,500 passes.

For red-sensitive and most commercial panchromatic plates use:

Naphthol green	. 115 grs.	12 g.
Filter blue (Hoechst 1 % solution)	. 460 mins.	48 ccs.
Gelatine (8 % solution) to	20 oz.	1,000 "

For pinacyanol and dicyanine bathed plates, the quantity of dyes may be reduced by one-third in the above formula. The same quantity of dyed gelatine per area should be allowed as stated above.

For liquid filters, that is for solutions of dyes in 1-in. thick cells, the following may be used:

Naphthol yellow S (Bayer)	9 grs.	1 gr.
Violet dahlia B O (Badische)	. 1.75 "	. 18 "
Glycerine or water to	. 20 oz.	1,000 ccs.

This gives a deep red only beyond about λ 685— λ 690.

A good green liquid filter is:

Acid green	. 12 grs.	. 25 g.
Naphthol green	. 12 "	. 25 "
Tartrazine	. 144 "	. 2.00 "
Glycerine or water to	. 20 oz.	1,000 ccs.

In all cases, it is advisable to soften down the direct light by a sheet of ground glass or tissue paper. Although a light is called safe, it is so only in a relative sense, and, therefore, care should be taken to expose the plate to it as little as possible.

SAL-AMMONIAC (See "Ammonium Chloride.")

SAL-SODA (See "Sodium Carbonate.")

SALICYLIC ACID (Fr., *Acide salicylique*; Ger., *Salicylsäure*)

Synonym, ortho-oxybenzoic acid. $C_6H_4(OH)COOH$. Molecular weight, 138. Solubilities, 1 in 450 water, 1 in 2.4 alcohol, 1 in 2 ether. It is a light, fine, white crystalline powder, either obtained from oil of wintergreen or sweet birch, or by the action of caustic soda and carbonic acid on phenol. It is occasionally used as a preservative in emulsions and solutions.

SALMON AND GARNIER'S PROCESS

One of the early iron or powder printing processes, introduced about 1857, based on the fact that the ferrous or iron salt resulting from ferric citrate is more hygroscopic than citrate itself. Paper was coated with ferric citrate, exposed under a positive transparency, and covered with plumbago or other impalpable powder. The surface was breathed upon, the powder then adhering to the parts acted upon by light, while the surplus could be lightly brushed off. The unacted-upon citrate was then washed out, the picture in powder being left. A later improvement was the mixing of loaf sugar or sugar of milk with the citrate. The dichromates subsequently were found to answer better than the ferric salts. (See also "Dusting-on (Powder) Process.")

SALON, PHOTOGRAPHIC (See "Linked Ring.")

SALT (Fr., *Sel*; Ger., *Salz*)

The common name for sodium chloride. There is a slight difference between the pure chloride and common salt, but the latter may be employed

in most cases when sodium chloride is named. A weak solution of salt is often used to remove or decompose the last traces of silver salts before the toning of prints, to prevent black metallic spots appearing on the pictures and, sometimes, blisters. It is perhaps the most widely used for self-toning papers, a preliminary bath of salt influencing the resultant tone considerably. Before the introduction of "hypo" a strong solution of salt was used for fixing. Salt acts more or less as a restrainer in a developer.

In process work, salt has its uses as described under the heading of "Dry Enamel Process"; further, it is used as an etching mordant for aluminium, and for making red prints for the bleaching-out process.

SALTED PAPER (See "Plain (Salted) Paper Printing.")

SALTING (See "Sizing and Salting.")

SALTPETRE (See "Potassium Nitrate.")

SALTS, HALOID (See "Haloid.")

SAND BATH

Actually a bed of sand supported in an iron vessel upon which is placed a dish containing the material that is to be heated, it being frequently undesirable to expose the dish or its contents to the direct heat of a flame. A saucepan or deep frying-pan almost filled with silver sand and heated over a gas burner or open fire, makes a good sand bath. A sand bath is recommended as a support for evaporating basins when boiling down the silver bath in the wet collodion process. Its object is to prevent the naked flame impinging on the basins and to diffuse the heat more uniformly. A layer of sand is also recommended at the bottom of collotype ovens.

SANDARACH (See "Gums and Resins.")

SANDELL PLATES AND FILMS (See "Multiple-coated Plates" and "Cristoid Film.")

SANGER-SHEPHERD COLOUR PROCESS

A process of obtaining three-colour transparencies by printing on to celluloid coated with bichromated gelatine containing a little silver bromide, developing, staining, and superimposing the results, after removal of the silver salt by "hypo." A method of obtaining colour prints on paper has been introduced by the Sanger-Shepherd firm, in which a hard gelatine relief is stained up and the dye transferred to a soft, moist gelatine film.

SATIN, PHOTOGRAPHS ON (See "Fabrics, Printing on.")

SATURATED SOLUTION (Fr., *Solution à saturation*; Ger., *Gesättigte Lösungen*)

A solution of a salt in any vehicle of such a strength that it will not hold any more of the salt in solution. The great disadvantage of saturated solutions is that their strength varies with the temperature, most salts being more soluble in hot than in cold liquids. Their use

should be avoided as far as possible, and all solutions made up of a definite and standard strength.

SATURATOR

An appliance for carburetting oxygen with ether and so forming a combustible gas to be burnt in a special form of limelight jet. It is a dangerous and now almost obsolete appliance. (See also "Limelight.")

SATZ LENSES

A synonym for casket lenses, applied by Zeiss to the sets of single anastigmats which could be used alone or to form combinations of various focal lengths.

SAVING WASTES (See "Residues.")

SAXE PAPER (See "Rives and Saxe Papers.")

SAYCE, B. J.

Born, 1837; died 1895. Secretary and, later, President of the Liverpool Photographic Association. With W. B. Bolton, of Liverpool, he discovered the collodio-bromide of silver emulsion process (published 1864).

SCALE, FOCUSING (See "Focusing Scale.")

SCALES AND WEIGHTS (See "Balances.")

SCALOL

A registered name for a preparation of methyl-paramidophenol (metol), for use in combination with hydroquinone.

SCALOMETER (See "Focusing.")

SCHIENDL'S INTENSIFIER

A mercuric chloride intensifier. The negative is bleached in a 1 in 20 solution of the chloride, washed, and blackened in a 1 in 100 solution of "hypo," to which a few drops of a gold chloride solution and of ammonia have been added. The method is said not to block up delicate detail in the high lights.

SCHLIPPE'S INTENSIFIER

An intensifier introduced by Carey Lea for wet-plate negatives, but now seldom used. An iodine solution (water, 2 oz.; potassium iodide, 3 grs.; iodine, 1½ grs.) was first flowed over the plate and then a solution of Schlippe's salt, a scarlet deposit being produced.

SCHLIPPE'S SALT

A synonym for sodium sulphantimoniate.

SCHWELLENWERT (Ger.)

A term used by Eder to designate that quantity of light which is necessary to produce a distinctly noticeable photographic effect. This is usually translated "threshold" in English, and is practically confined to the smallest amount of exposure necessary to give a visible image after development. It was at first assumed that this Schwellenwert was a physical constant below which no action whatever occurred, but it is quite easy to measure far below it by counting the number of silver grains under a microscope (Mees and Sheppard).

SCOLIK'S INTENSIFIER

A mercuric chloride intensifier. The washed negative is immersed until whitened in a solution of 48 grs. of mercuric chloride and 48 grs. of potassium bromide in 5 oz. of water, blackened in a sodium sulphite solution, and finally washed.

SCRAPING NEGATIVES (See "Knife, Retouching.")

SCRATCHES ON NEGATIVES

A scratched negative is repaired satisfactorily only if the photographer is expert with the pencil. If the scratch is clean and shows as a black line only in the print, the negative should be varnished, a little retouching medium applied, and the scratch gradually worked out with a finely-pointed hard pencil. Avoid working beyond the scratch, or filling it up too solidly, and it is better to stop while the scratch can still be seen as a faint grey line, rather than to obliterate it completely, when it may print as a white line. Abraded edges to a scratch, which print white at each side of the black line, should be carefully scraped away with a sharp knife before varnishing the plate.

SCREEN, COLOUR (See "Colour Screen or Filter.")

SCREEN, FLUORESCENT (See "Fluorescent Screens.")

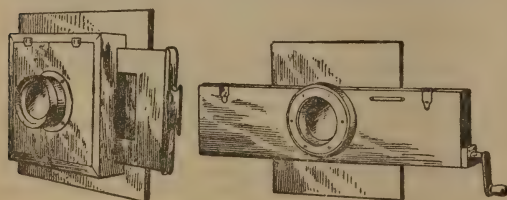
SCREEN, FOCUSING (See "Focusing Screen.")

SCREEN, GRADUATED

A screen or light filter of glass or celluloid, graduated in density (colour) from the top to the bottom, the top part being as a rule, of a deep yellow colour, which gradually decreases in density until at the bottom quite clear glass is reached. Such screens are used for placing in front of the lens when photographing landscapes, the denser part being so adjusted in the holder, which fits on the front of the lens, as to cover the sky portion, in order to retard the action of the blue rays upon the plate. The use of such a screen makes it possible to get foreground and skies, both correctly exposed, on one plate; without it, if the foreground were properly exposed, the sky would probably be over-exposed and any delicate clouds lost.

SCREEN HOLDER

Process workers use various forms of holders for fixing the colour filters parallel to the lens.



A and B. Screen Holders

Some of these holders are arranged to work in front, but behind the lens is the more common and the better position. Circular colour filter

cells are attached to the front of the lens by means of a holder which clamps together the glass components of the cell. A is a wooden holder, which is attached to the front of the camera, the lens being mounted in front of the box. B is a box to hold three filters in line, so that they may be pushed successively past and behind the lens. In addition to these, circular fittings of metal are used.

SCREEN, ISOCHROMATIC (See "Isochromatic Screens.")

SCREEN - PLATE COLOUR PHOTOGRAPHY

The process of producing photographs in the colours of Nature by means of a screen plate is based on the three-colour process enunciated by Clerk-Maxwell, but instead of using three separate colour filters and three separate plates and prints, the colour filters are distributed on one surface in small areas, coated with a panchromatic emulsion, and the picture obtained on this support either by chemical reversal of the negative into a positive or by printing on to another plate of similar character.

The first idea of such a plate was conceived by Ducos du Hauron, in 1862, in a letter which, however, was not published till 1897. In his French patent (No. 8,361, of Nov. 23, 1868) du Hauron says: "There is another method by means of which the triple operation can be done on one surface. The separation of the three elementary colours may be effected, no longer by three coloured glasses, but by means of one translucent sheet covered mechanically by a grain of the three colours." In a little work by him, *Les Couleurs en Photographie, Solution du Problème* (1869), he also deals with this subject, but a more elaborate description of this idea is given by Alcide du Hauron in *Triplique Photographique des Couleurs*, in which will be found the germ of all screen-plate processes, and any introduced of late years have been but variations of du Hauron's ideas.

In dealing with this subject the writer cheerfully acknowledges that he is following to a great extent and sometimes borrowing freely from a valuable paper on "Some Experimental Methods Employed in the Examination of Screen Plates," by Dr. Kenneth Mees and J. H. Pledge (*Phot. Journal*, May, 1910, p. 197). Screen-plates may be classified under two headings: regular and irregular, or line and mosaic; and can be further subdivided into the following methods of manufacture: (1) ruled lines, (2) dusting-on methods, (3) bichromated colloid methods, (4) section cutting, (5) mechanical printing or mechanical methods and dyeing, (6) other processes.

The first line screen by a ruling method was patented by Joly in 1895, patent No. 14,161, '95. In 1896, Jas. W. McDonough took out patent No. 12,645, '96. The Joly screen was composed of lines having a width of $\frac{1}{16}$ in. (.12 mm.), and a separate viewing screen, with slightly different colours, was issued. The taking screen was placed in contact with a panchromatic plate, and from the line negative thus obtained a positive was made and bound up with a viewing screen so adjusted that the lines of the latter

fell into contact with the correct lines of silver deposit on the positive. The McDonough lines were $\frac{3}{16}$ in. (0.8 mm.) wide, and some even as fine as $\frac{1}{16}$ in. were made. The dusting-on method was first patented by McDonough (No. 5,597, '92), and he claims the use of particles of glass, transparent pigments, gelatine, resin, or shellac suitably stained and subsequently coated with a panchromatic emulsion.

The autochrome plate, patented (22,988 and 25,718 of 1904, and 9,100 of 1906) by Messrs. Lumière, is prepared by sifting suitably stained starch grains over a tacky surface, rolling them, and then filling the interspaces with a black filling. The average size of the starch grains is $\frac{1}{16}$ in. (0.15 mm.). The plate is issued coated with an emulsion, and the image needs to be reversed after exposure, so that the original plate serves as the positive.

According to Mees and Pledge, Fawcett suggested in the *British Journal of Photography* (February 22, 1901) the use of a screen plate with the emulsion coated thereon.

Palmer's patent (22,228, 1907) claims the use of ceramic colours or fluxes dusted on a tacky glass plate, and then fired in a kiln; also in another plate he uses gum elemi. The Aurora screen plate (introduced by the inventor, E. Penske, in February, 1909) uses a mixture of three dyed materials dusted on a tacky plate, and fills the interspaces with a black filling. The fragments vary in size from $\frac{1}{16}$ in. (0.3 mm.) to $\frac{1}{16}$ in. (0.15 mm.), the average being about $\frac{1}{16}$ in. (0.07 mm.).

In Bamber's patent (3,252 of 1908) dyed gelatine is hardened with formaldehyde, dried, immersed in water, heated to 212° F. (100° C.), ground to powder, and sifted into varying sizes by elutriation with petroleum spirit; then it is dusted on tacky glass and expanded by absorption of moisture from the air, the interspaces being then filled up with black filling. The average size of the particles is about $\frac{1}{16}$ in. (0.01 mm.).

The use of bichromated colloids was outlined by Du Hauron, and the first plate manufactured on these lines was the Warner-Powrie or Florence plate. The lines in this had a width of about $\frac{1}{16}$ in. (0.04 mm.), and the green lines were formed first, then the red, and the interspaces were filled with blue. Another Warner-Powrie experimental screen plate had green lines with red and blue rectangles in between, thus following more closely still the Du Hauron method; the diameter of the green line was $\frac{1}{16}$ in. (0.05 mm.), the narrow diameter of the red areas being $\frac{1}{16}$ in. (0.07 mm.) and that of the blue $\frac{1}{16}$ in. (0.05 mm.).

Dr. Smith, of Zurich, patented (6,881, 1906) a screen plate with regular geometric pattern, triangles, hexagons, or rhombi. The Thames plate (Finlay's patent, 19,652 of 1906) consists of a series of red and green circles of about $\frac{1}{16}$ in. (0.11 mm.), with a blue filling. It is interesting to note that in an American patent (561,687 of 1896) McDonough claims the use of "a negative or positive photographic plate made with recurring patterns—as dots, lines, or figures—and having a portion where there is a fixed or invariable and distinctive characteristic which is produced in the sensitive material

of the plate, and by which the plate may thereafter be registered or adjusted in position in use."

The Wratten patent (28,406 of 1907) has one distinctly novel feature in that the matrix, whether a linear or dot pattern, has the figures in black, semi-opaque, and clear, and therefore one would have, in printing on a bichromated dyed colloid, a quite insoluble, a half soluble, and a completely soluble film. After exposure, the insoluble gelatine would be stained deep blue, the half soluble only half that depth, and a clear line left; by immersing such a plate in a yellow dye the half soluble line would absorb the yellow and give green, and the clear line could be subsequently coated with a red colloid and rendered insoluble. Practically this did not work out so well as it promised.

The Dufay dioptrichrome plate (patents No. 11,698 of 1908 and 18,744 of 1908) is prepared by exposing a bichromated colloid under a line screen, dyeing, and inking up with a greasy ink which does not adhere to the stained lines; and this plate is now pressed against a gelatine-coated plate and the ink and dye are transferred. This second plate is coated with a varnish which does not adhere to the greasy ink, and then treated with a solvent which dissolves the ink and does not attack the coloured line; and the plate then has one third of its surface red and two-thirds plain. A second printing at right angles to the first gives the second colour, and then the unstained gelatine is dyed by pressure against another plate stained with the third colour. The green line has a diameter of $\frac{1}{16}$ in. (0.06 mm.), the red rectangle $\frac{1}{16}$ in. $\times$ $\frac{1}{16}$ in. (0.07 mm. $\times$ 0.1 mm.) and the blue area $\frac{1}{16}$ in. $\times$ $\frac{1}{16}$ in. (0.05 mm. $\times$ 0.09 mm.).

The only plates prepared by the fourth method so far have been experimental ones. Señor Cajal, of Madrid, suggested the use of coloured fibres embedded in celluloid rendered opaque by metallic silver and cut across with a microtome. In 1893, Dr. Otto N. Witt applied for a German patent (W. 14,564, iv., 57A, November 1) for preparing linear filters by the superposition of sheets of dyed celluloid, cementing them together and then rolling them out to thin veneers. On April 6, 1899, R. E. Liesegang applied for a similar patent, in which the block of superposed sheets of celluloid was to be cut across at right angles to the direction of the lines, and mosaic filters could be produced by cementing such veneers into a block and again cutting across. R. Krayn took out two English patents (1,938 of 1906 and 495 of 1907) for precisely the same ideas, and experimental films of this character were issued.

The Krayn screen, which has been actually issued, belongs, like the Omnicolore plate, to the fifth method, in which mechanical printing is employed. The method is practically as follows: a greasy ink or waterproof varnish is ruled over two-thirds of the surface of a gelatine-coated or celluloid film (Krayn), and the exposed gelatine is dyed and the water-repellent material removed and again applied so as this time to cover the dyed gelatine and half the unstained gelatine. The exposed gelatine is dyed and mordanted and then the remaining clear gelatine stained up. In the Omnicolore plate there

are continuous blue lines of $\frac{1}{800}$ in. (.05 mm.) width with green and red rectangles in between at right angles, the area of the former being about $\frac{1}{360}$ in. $\times$ $\frac{1}{360}$ in. (.08 mm. $\times$.06 mm.), and that of the latter $\frac{1}{360}$ in. $\times$ $\frac{1}{360}$ in. (.06 mm. $\times$.04 mm.). In the Krayn celluloid film the lines are red and about $\frac{1}{800}$ in. wide, and the blue and green rectangles are not at right angles, but about an angle of 135 with the horizontal red line, and the space between the two red lines is about $\frac{1}{360}$ in. (.11 mm.). Lumière's patent (20,111 of 1908) for a regular grain screen is based on the use of a greasy ink, which is applied to two-thirds of the surface of a gelatine film, the remaining third being dyed; then the whole plate is varnished and the greasy ink and the overlying varnish dissolved. A second greasy ink is now applied in the form of lines at right angles to the first set, so that half the surface is covered, and the exposed gelatine is dyed in the second colour, again varnished, and the greasy ink removed; and the plate, which now bears two colours, is dyed up as regards its remaining surface with the third colour.

With regard to screen plates made by other processes, there are not at present any on the market, though several patents have been taken out, such as Joly's (19,388 of 1895) for dyed threads laid on a transparent support, Beeton and Gamb's patent (20,834 of 1906) for a woven tissue, and Szczepanik's (17,065 of 1908) on the same lines.

The Szczepanik-Hollborn screen plates are based on the affinity of basic dyes for acid tissues and acid dyes for basic tissues; the former have a decided preference for collodion and acid dyes for gelatine. Three solutions of gelatine or other colloid are dyed, dried, powdered, mixed in proper proportions, and dusted on to a moist collodion plate. The dyes pass from the colloid into the collodion, and the former is washed off, leaving a mosaic of coloured areas. In the second form only two colours are applied in this way and the third applied by a dyeing bath.

There are certain factors in the manufacture of screen plates which are extremely important for the successful reproduction of colour, and the first is that the screen itself should be free from colour when examined by white light; that is, it should be of a neutral shade. This has been defined by Mees as the "first black condition," and it must be attained by adjustment of the areas of the colour units, and not by varying the depth of staining which controls their absorptions. The second point is that the photo-chemical effect of the spectrum through the screen elements and compensating filter must correspond with the luminosity curve, though this point may be of less importance, as the retina is able to perceive small variations from the correct curve. The third point is the total visual absorption, as this affects the duration of exposure, for, naturally, the greater the absorption of light the longer will be the exposure. The above-mentioned authors state that in order to fulfil the first black condition the green area must transmit about two-thirds of the light transmitted by the plate, and under the best conditions for the other filters it may occupy half the area of the plate, and therefore half the plate will only transmit one-third of the incident green light

or two-ninths of the incident white light, so that the whole plate will transmit only one-sixth of the incident white light as a maximum.

The question of invisibility of the filter elements depends upon what has been termed the "period," which is twice the distance of separation for lines equal in width to the spaces; and this must be less than $\frac{1}{1000}$ of the distance from the eye; and if this be taken as 20 cm. the screen period will be 0.2 mm.; therefore the separate filter elements will be invisible if they are not larger than $\frac{1}{800}$ in. (.066 mm.), or approximately $\frac{1}{800}$ in., this naturally applying to results examined in the hand. When, however, it comes to the projection of the pictures, one has to take into consideration the magnification, and assuming this to be 40 diameters or a 10-ft. screen, and the nearest observer to be 12½ ft. away, the screen elements must not be more than $\frac{1}{800}$ in., which requires the actual screen elements to be $\frac{1}{800}$ in. When dealing with irregular grain screens in which the units are distributed by a dusting-on method, then there may be clumping of the grains; as many as twelve grains may be clumped together, and therefore the unit may become much larger.

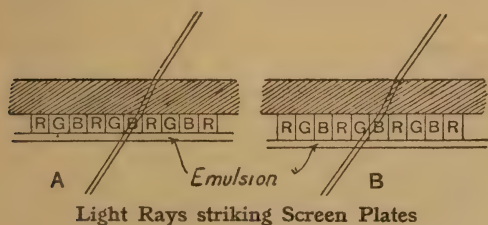
The resolving power—that is, the power of the screen plate to resolve a coloured object into its form and colour—may be divided into three heads. First, the objects are resolved both in form and colour, when the images of the objects are as large as or larger than the screen period; secondly, the images may be of the same size as the screen elements, then they will be resolved as to form but indeterminate as to colour; thirdly, if the images are smaller than the screen units, they may or may not be resolved, according to the resolving power of the emulsion.

The spectral absorptions of the filter elements can only be those which are generally recognised in three-colour work—that is, having a slight overlap in the yellow and blue, considering the taking of negatives only; but as, in the majority of cases, the screen is also used for viewing, the spectral absorption should be as pure as possible, and should agree as nearly as possible with the three fundamental colours—red, green, and blue. A compromise has therefore to be made, and probably the red should transmit from the extreme red to λ 5,900, the green from λ 5,900 to λ 4,900, and the blue from λ 5,000 to λ 4,000.

The limitation of the size of the filter element is determined by the invisibility of the element, which has been previously dealt with, and this should be not larger than $\frac{1}{800}$ in., or in the case of irregular grain screens about one-tenth of that, because of the clumping. One of the factors governing the minimum size of grain is the thickness of unit necessary to give sufficient depth of colour, which is determined as to its diameter by parallax. If the thickness is equal to the diameter, any ray passing through the screen at a greater angle than 10° will not only pass through the particular element which it first struck, but also the next, as shown in the following diagrams.

A shows a screen plate in which the thickness of the filter elements R, G, B (red, green, and blue) is equal to their diameter. The ray striking the blue element B passes only through this; but as the emulsion is of slightly greater refractive

index it encroaches slightly on the neighbouring green element, and therefore in the final result the blue would have a very slight green tinge. In diagram B the thickness of the elements is one and a half times their diameter, and the ray here passes not only through the blue, but



through nearly the whole of the green; therefore the final colour would be strong greenish blue. This is an important point because when using a bichromated colloid, such as gelatine, it is difficult to get sufficient depth of colour with less than 54.5 mins. of 5 per cent. gelatine solution to every 10 sq. in. (= 1 cc. per 20 qcm.), which gives a thickness of dry film of $\frac{1}{1000}$ in. The second factor limiting the size of the elements is the irradiation of light in the emulsion film itself, by which the light may be scattered from the silver halide particles, underlying the particular screen element, to those under the adjacent ones.

Finally, in order to obtain correct colour rendering, assuming that the first black condition is fulfilled, it is essential that the action of light should be to give equal deposit under all three elements. Now, as it is not possible to sensitise any emulsion for red and green, so as to give equal sensitiveness to these regions as to the original blue-violet sensitiveness of the emulsion, therefore a compensating filter is used to cut down the excess blue-violet sensitiveness, and at the same time even up the sensitiveness of the red and green. This is called the "second black condition."

The final speed of a plate is determined by (a) the speed of the emulsion, (b) the multiplying factor of the screen, and (c) the multiplying factor of the compensator. Mees and Pledge give the following table of these factors:—

	Auto-chrome	Thames	Omnichrome	Dufay
Emulsion speed (Watkins)	35	120	22	13
Screen factor	12	8	7	5
Compensator factor	2	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{2}$
Effective speed	$1\frac{1}{2}$	10	$2\frac{1}{2}$	2

They also give the following very valuable summary of the essentials to be fulfilled in the manufacture of a screen plate: (1) The size of the units.—For regular screens these should not be larger than $\frac{1}{16}$ in., nor smaller than $\frac{1}{64}$ in. For irregular screens not larger than $\frac{1}{16}$ in., nor smaller than $\frac{1}{64}$ in. It is quite needless to strive for exceedingly small units. (2) The

interstices.—If these exist at all, they must be filled in; white interstices are fatal, even if they only occupy one-twentieth of the arc of the screen plate. (3) The colours of the units.—These must be primary red, green, and blue violet. (4) The relative area occupied by each colour.—This must be adjusted to fulfil the first black condition. (5) Emulsion.—This must be coated, for which purpose insulating varnishes will have to be selected, as they must not act upon it. Turpentine and ether, especially the former, are inadmissible as solvents; resin varnishes are suspect. (6) The sensitising.—This must be performed so that the actions under the red and green filters are equal. (7) The compensator.—This must be adjusted to fulfil the second black condition.

SCREEN, RULED (See "Half-tone Process" and "Half-tone Screen.")

SCREWS AND SCREWTHREADS (See "Camera Screw" and "Mounts, Lenses.")

SCULPTURE, PHOTO. (See "Photo-sculpture.")

SCULPTURE, PHOTOGRAPHING

The principal points that require attention in photographing sculpture are given under the heading "Statuary, Photographing"; but it is desirable to give a hint in this place on the photographing of sculptured panels. With most of these panels, a direct front position is almost imperative; the panel must be regarded almost as a picture and photographed in the same manner. Care must be taken to get the outlines of the panel perfectly rectangular, the corners square and the opposite sides parallel. The most simple method is given under the heading "Paintings, Photographing." The front position does not always show the relief so effectively as an oblique view, consequently, when possible, the work should be done at the time of day when the natural lighting gives the desired effect.

SECONDARY AXIS (See "Optical Axis.")

SECRET CAMERAS (See "Detective Camera" and "Disguising the Camera.")

SEED LAC (See "Gums and Resins.")

SEL D'OR (See "Gold Hyposulphite.")

SELECTIVE SENSITISERS

A synonym for optical sensitisers, under which heading they are described.

SELENIUM

Se. A non-metallic element. Atomic weight, 79. It is used in phototelegraphy.

SELF-DEVELOPING PLATES

Dry plates carrying the developer in or on the film, or on the glass side, and requiring only to have water applied for the developing action to take place. An early form was that introduced by Dr. Bäcklandt, who soaked dry plates in a solution containing salicylic acid and pyrogallol acid. The systems by which the developer

is in the form of a dried paste on the glass side of the plate are far more satisfactory. Thomas Bolas patented (in 1907) a dry developer, to be applied to the glass side of the plate or used as a separate sheet. In addition to claiming the distribution of different portions of the developer in different parts of the area, the use of hydroxylamine and an ammonium salt is named, also the use of acid sulphite, and the use of bicarbonate as an alkali. The acid constituent (A) may contain the reducing agent:—

Metol	1 part
Hydroquinone	2 parts
Milk sugar, mannite, or other sugar-like preservative	1½ "
Sodium bisulphite	1½ "
Starch, partly boiled and partly in grains	6 "

and water in sufficient quantity to give a paint-like consistency on a thorough incorporation or grinding of the ingredients. Instead of metol and hydroquinone, other reducing (developing) agents may be employed. The alkaline accelerator (B) may contain the following ingredients:—

Sod. carbonate or bicarbonate	5 parts
Gum arabic	1 part

and water in sufficient quantity to give a paint-like consistency to the mixture upon grinding. The inert or slightly acid separating material (C) may contain the following ingredients:—

Sulphate of lime or sulphate of baryta	4 parts
Gum arabic	1 part

and water as before.

SELF-PORTRAITURE

When there are no bright objects in the background and the duration of exposure is of little or no importance, a small stop may be inserted in the lens in order to make a comparatively long exposure necessary. The operator may then open the shutter or uncap the lens and take up his position at a suitable spot previously arranged opposite the camera, stay there while the exposure is being completed, and then go back to the camera and close the lens. The brief period during which the operator is not in position will make no appreciable difference to the plate if the stop used is small enough, the plate slow enough, and the background dark enough. Another and a better plan, suitable for outdoor groups when the operator wishes to be included, is to make the exposure through the agency of black thread. Two lengths of black thread, long enough to reach from the camera to the operator should be taken. One is attached to the lens cap (a shutter cannot be used), and the other is tied to one corner of the focusing cloth, the latter being folded on the top of the camera in such a way as to be easily pulled over the lens. When all is ready for the exposure the thread attached to the cap is pulled, the cap then falls to the ground and the exposure begins; when sufficient exposure has been given the thread attached to the black focusing cloth is pulled and the cloth falls in front of the lens; the operator then hastens back to the camera and caps the lens.

SELF-TONING PAPERS

Printing-out gelatino-chloride emulsions containing some salt of gold, which is reduced in the fixing bath and thus tones the image and does away with the necessity of separate toning. Ashman and Offord suggested this addition in 1885; but Bachrach, three years later, published the fact that the addition of gold obviated subsequent toning. Most of these papers require merely fixing or immersion in a preliminary salt bath to vary the tone obtained. In some cases the gold is accompanied by lead or other metallic salts, which doubtless play an important part in the toning of the image.

SELLA'S PRINTING PROCESS

A process published by M. V. J. Sella, of Biella, in 1857. It was an "ink" process, in which the salts of silver and gold were superseded by salts of iron and chromium.

SEMITONE (Fr., *Demiteinte*; Ger., *Halbton*)

A half-tone. In photography, the shades intermediate between the lightest parts of the picture (high lights) and the deepest shadows.

SENSITISED PAPER (Fr., *Papier sensible*; Ger., *Gesilbertes Papier*)

An old term applied to plain salted and albumenised paper after sensitising with silver nitrate.

SENSITISERS (Fr., *Sensibilisateur*; Ger., *Sensibilisatoren*)

There are practically two classes of sensitisers, the so-called chemical, and the optical sensitisers. The former are generally halogen absorbers, which increase the sensitiveness of the negative emulsion or increase the intensity of the printed out image. For colour sensitisers, see "Colour Sensitising."

SENSITISING

Rendering sensitive to light. Methods for sensitising are given under the various processes, as for example, blue-print, kallitype, carbon, albumen, etc.

SENSITIVENESS OF PLATES AND PAPERS

The question of the sensitiveness of plates is dealt with under "Sensitometry." At present there is no generally accepted method of testing papers for their sensitiveness, the usual commercial method being merely to give the exposures to certain lights.

SENSITIVENESS, RESTORING (See "Fogged Dry Plates, Restoring.")

SENSITOMETER

A device for testing the sensitiveness of plates and paper, and described in the following article.

SENSITOMETRY (Fr., *Sensitométrie*; Ger., *Empfindlichkeitsmessung*)

Soon after the introduction of the gelatine dry plate, it was usual to express the speed of the emulsion as " x times," which meant that it was x times the speed of a wet collodion plate. This

speed was no fixed quantity, and the expression consequently meant but little. Warnerke introduced a sensitometer, consisting of a series of numbered squares with increasing quantities of opaque pigment. The plate to be tested was placed in contact with this, and an exposure made to the light emanating from a tablet of luminous paint, excited by burning magnesium ribbon. After development and fixation the last number visible was taken as the speed of the plate. The chief objections to this method were that practically no two numbered tablets agreed, that the pigment possessed selective spectral absorption, and that the luminosity of the tablet varied considerably with the lapse of time between its excitation and the exposure of the plate. Various other methods were proposed, but none found any practical use. In 1890, Hurter and Driffeld published a series of papers on the subject of speed determination, and proposed a method of exposing a plate to a series of lights of known intensities and measuring the densities obtained on development. This method has become very general in England, though possibly it is not strictly adhered to by all its users. Notwithstanding various attacks, the main principles of the

is that the "opacities" of the silver deposited are so great that they possess very little "transparency"; that is to say, the negative absorbs the greater portion of the incident light. It is true that the "denser" a negative the greater the opacity, but it must not be forgotten that, as defined above, density is the quantity of silver deposited. Density is the logarithm of the opacity; thus, a negative which has an opacity of 100 has a density of 2.00, as this is the common logarithm of 100, and it has a transparency of $\frac{1}{100}$.

The usual mathematical expression of the above facts is as follows, but in the following pages, as far as possible, mathematics will be excluded and everyday working instructions given:—

$$\text{Transparency, } T = \frac{\text{Intensity of light transmitted}}{\text{Intensity of incident light}} = \frac{I}{I_0}$$

$$\text{Opacity, } O = \frac{\text{Intensity of incident light}}{\text{Intensity of transmitted light}} = \frac{I_0}{I} = \frac{1}{T}$$

$$\text{Density, } D = -\log_{10} T = \log_{10} O$$

The last term is also frequently expressed as:—

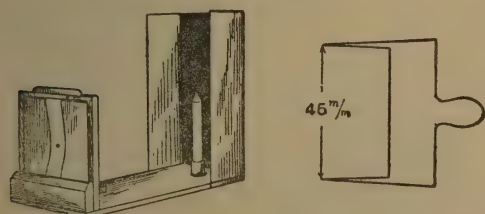
$$D = -\log T = \log O,$$

Napierian, instead of common, logarithms being used.

Hurter and Driffeld pointed out that in a perfect negative the opacities of the different gradations were strictly proportional to the light reflected by those portions of the subject which they represented when the plate had received correct exposure, and that a true representation of the tones of the original is only possible when the density or the quantity of silver is proportional to the logarithm of the light intensity. To use the H. and D. system correctly, it is essential to have a standard light, an exposing instrument, and a photometer or instrument for measuring the densities.

The Standard Light.—The light adopted by Hurter and Driffeld was the British Standard candle, burning 120 grains of spermaceti wax per hour. This candle gives satisfactory results as regards the speeds of ordinary (non-colour sensitive) plates for amateur use; but the flame is subject to fluctuations, and obviously will give totally incorrect readings with colour-sensitive plates, on account of the spectral composition of the light, this being very yellow, or much richer in yellow, orange, and red rays than is daylight. If the candle is used for speed reading, it is always advisable to expose with the plate to be tested one of a known speed, then any variation of the speed of the latter can be allowed for in calculating the speed of the unknown plate. It is important to see that the candle is burning regularly at the base of the wick, with a well-formed cup of wax, free from match-heads, bits of charred wick, etc. The wick should burn over at its top to the edge of the flame, the latter being 45 mm. in height from that place where the wick begins to blacken to the tip of the flame. It is as well to make a steel metal gauge, as shown at B, for measuring this height, and it is also desirable to shield the candle flame from draughts. As it must be kept at a constant height, a retort stand with a slip arm to hold the candle, or a sliding holder, must be provided.

Another standard light, more generally used



A. Chapman Jones Plate Tester

B. Gauge for Height of Candle Flame

H. and D. system, as it is briefly termed, remain uncontroverted. On the Continent, another system, known as Scheiner's, has been elaborated by Eder, and in this a rotating sector wheel is used, the steps of which bear a ratio of 1 : 1.27. After exposure, the last number visible, when the negative is placed film downwards on white paper, is taken as the speed of the plate.

Chapman Jones has introduced a modified Warnerke tablet containing a series of twenty-five graduated densities, a series of coloured squares, and a strip of neutral grey, all five being of approximately equal luminosity, and a series of four squares passing a definite portion of the spectrum; finally, there is a square of a line design, over which is superposed a half-tone negative. This "plate tester," A, is used with a standard candle as the source of light, and is useful for rough tests of both plates and printing papers. Definitions of the leading terms employed must here be given. "Opacity" is the suppression or absorption of light by the silver image. "Transparency" is the remnant of the original light which passes through the negative image. "Density" is the relative quantity of silver deposited per unit area. The existing confusion is well shown by the term "a very dense negative," when really what is meant

on the Continent, is the Hefner amyl-acetate lamp, a small lamp which burns pure amyl-acetate that gives a flame much like the candle in spectral composition, and, therefore, open to the same objections on this score as the standard candle.

The most satisfactory standard light is acetylene, used under a pressure of about $\frac{1}{2}$ oz. The burner to be used is a Bray's "Elta," which shows no tendency to carbonise, and in which the gas escapes from two pinholes in the steatite caps. These caps contain airholes. The rod-like flames impinge against one another and produce a brilliant flat flame of about 1 in. diameter. Whereas in the candle the whole flame is used, in the case of acetylene it is important to screen off the margins and the tip of the flame as these flicker considerably, and it is also necessary to screen off the blue base of the flame. This can be conveniently done by a Methven screen or metal plate pierced with a square hole of 36 sq. mm. area. This screen should be as near the flame as possible (about 12, or not more than 18 mm.), and the bottom of the aperture should be slightly above the dark or blue area of the flame, so that it is central with the whitest and most luminous part of the flame. For exact photometric investigations, the correct position must be found by exposing a series of plates and measuring the densities, but for practical speed testing it will be sufficient if the eye, when placed at the extreme edges of the dark-slide, can see no trace of the tip, edges or base of the flame. Renwick, of the Ilford Research Laboratory, states that there is a variation in density over the plate strips due to the variation in the intensity of the light and the small area of the flame exposed by the aperture. While this has not been confirmed by any other writer, Sheppard and Mees have confirmed the general fact that such a burner is liable to variation, and have, therefore, suggested a modification of the Fery cylindrical flame, obtained by means of a Bray burner taking .25 ft. of acetylene per hour, and constructed to give a cylindrical flame with the admixture of air. The burner is enclosed by a metal hood in which is an aperture .04 mm. and a cone reaching from this to within $\frac{1}{4}$ in. of the flame itself, the latter being 35 mm. in height.

The correct distance between the standard light and the sensitive surface should be 1 metre; if this is not adhered to a correction must be made in estimating the intensity of the light falling upon the plate. This correction, for varying distances is found from Schwarzschild's formula and table, given below.

$$I = \left(\frac{100}{D}\right)^2 f$$

TABLE OF CORRECTION FACTOR f .

G	D					
	400 cm.	200 cm.	100 cm.	50 cm.	40 cm.	30 cm.
0 cm.	0.989	0.992	1.000	1.017	1.023	1.337
4 "	0.989	0.991	0.997	1.007	1.009	1.01
8 "	0.989	0.989	0.990	0.978	0.965	0.935
12 "	0.988	0.986	0.979	0.934	0.899	0.829
16 "	0.986	0.982	0.962	0.879	0.818	0.712

D = the distance of the light, G = the distance of any point of the plate x centimetres from the perpendicular drawn through the centre of the flame to the plate. A reference to and explanation of this table will be found under the description of the exposing instrument.

The experimenter must not overlook the danger of the intensity of the light decreasing as the gas supply and, consequently, the pressure diminish, and he should take care that the evolution of gas has ceased before exposure is made. Another point is that when the carbide receptacle is freshly charged, some air is always introduced into the gas chamber, thus leading to a decrease of luminosity of the flame. This trouble may be overcome by generating a small quantity of gas first and burning this, with the water supply cut off, and then admitting more water to the carbide till the bell is fully charged, making the exposure when the generation of the gas has ceased.

Although the acetylene light approximates more nearly to daylight than the standard candle, it is still too rich in red and orange rays, and it should be screened down with absorbent solutions. The necessary dyes are gentian violet, acid green, mandarine orange and rose Bengal, which can be obtained in conveniently small quantities. Some pure copper acetate will also be required.

The dyes can be most conveniently made up into stock solutions as follow:—

A. Gentian violet	14 grs.	2 g.
Distilled water to	16 oz.	1,000 ccs.
B. Acid green	7 grs.	1 g.
Distilled water to	16 oz.	1,000 ccs.
C. Mandarine orange	7 grs.	1 g.
Distilled water to	16 oz.	1,000 ccs.
D. Rose Bengal	28 grs.	4 g.
Distilled water to	16 oz.	1,000 ccs.

These stock solutions must be kept in the dark.

The actual filter or screen is made as follows:

A solution	10 mins.	1 cc.
B "	10 "	1 "
C "	10 "	1 "
D "	10 "	1 "

Distilled water to 2 oz. 138 mins. or 100 ccs.

When mixed, this will not keep more than 24 hours, and it should be used in a cell 10 mm. internal width.

The copper acetate solution is made as follows:

Pure copper acetate	105 grs.	15 g.
Glacial acetic acid	35 mins.	.5 g.
Distilled water to	16 oz.	1,000 ccs.

This will keep indefinitely, and must be used in a cell of 10 mm. internal width. It must not be mixed with the aniline dyes, but used in a separate cell.

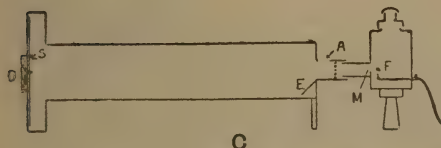
The Exposure Instrument.—The instrument for obtaining the series of graduated exposures consists essentially of a sector wheel, 11 in. in diameter, in which each sector is exactly half the preceding one; the angles should be: 180°, 90°, 45°, 22.5°, 11.25°, 5.625°, 2.8125°, 1.40625° and .7031°. Obviously the 180° is made up of the single quadrant below the centre and the quadrant next above. These angles must be accurately cut, an extremely difficult and costly

matter. The metal should be blackened and the edges of the angles bevelled, so that the edge of the bevel comes next the plate. The wheel is mounted in a box so that it can rotate as close as possible to the plate, and it will be found more convenient in practice if the space between the wheel and light is boxed in and the light also enclosed so that it can be used in a dark-room. Such an arrangement obviates any possible source of error from light reflected from the walls and ceiling of the room, and enables one to attend to other matters whilst the plate is exposing.

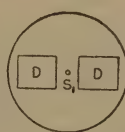
Diagrams C and D show an instrument made by E. J. Wall, which may be taken as a guide. The two dark-slides, D D, enable the experimenter to expose four plates at once, using the halves of quarter-plates, that is, strips of plates, measuring $4\frac{1}{2}$ in. by $1\frac{1}{8}$ in. The light is placed central with S, the axis on which the sector wheel revolves. This introduces a small error, which can be calculated from Schwarzschild's table already given, but for practical speed testing this may be neglected as it is less than the probable error in reading the density. For accurate photochemical work, the perpendicular from the centre

per minute the intermittency error is practically negligible. The sector wheel may be driven by hand, a small electric motor, a small water turbine or hot-air gas-engine. Hurter and Driffield used the treadle table of an ordinary sewing machine; but some mechanical arrangement will be found most convenient, as it allows the operator to attend to other matters.

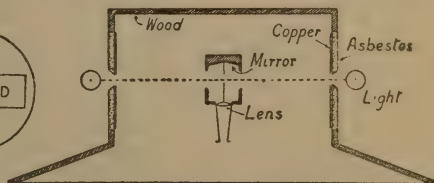
To use the apparatus, attention should first be paid to the light to see that it is burning correctly, the sector wheel should then be set in motion and the exposing shutter withdrawn. For fast plates, an exposure of 40 candle-metre-seconds will be sufficient as a rule, whilst for slow plates 80 C.M.S. may be given. For lantern plates this may be even doubled or quadrupled, so as to obtain the characteristic curve of the plate. Even with the largest sector, only half the circle, or 180° , is used for the exposure, so that no matter what exposure may be decided upon, it must then be doubled; in other words, ignoring the intermittency error, if the actual exposure is 80 secs. the effective exposure will be only 40 secs., as half the time the plate is covered by the opaque portion of the sector wheel. If the candle is used, then we may give



C and D. Wall's Exposure Instrument



D



E. Grease-spot Photometer

of the flame should coincide with the centre of the plate.

It will be found advisable to provide the dark-slides with $\frac{1}{8}$ -in. strips of black paper or thin metal, along the two sides, so as to have two fog strips, the use of which will be explained later. The dark-slides should be made in the form of a printing frame with solid back; the ordinary form may be used, but it rarely permits of one plate being placed behind the other, as sometimes required. C and D are practically self-explanatory; S is the sector wheel; D D the dark-slides; M the Methven screen with circular aperture; and F the acetylene flame. Small pieces of wood are fastened to the sides, top and bottom of the box, inside, to prevent scattered light reflections. The inside of the box must be blackened. A is an aperture cut in the top of the narrow portion of the box into which the two liquid cells for screening the light are inserted. As the flame is so near the aperture in the screen, this gets very hot, and it is advisable to have the outer sleeve, into which the projecting piece of the lamp slides, lined with asbestos cloth. E is an exposing door which, by means of a milled head outside the case, can be raised or lowered so as to admit or shut off the light at will.

A series of intermittent exposures does not produce the same effect as the equivalent continuous exposure, but it has been shown by Sheppard and Mees that if the wheel is not driven at a greater speed than 100 revolutions

actual seconds, but in the case of the screened acetylene light, it is necessary to find by actual test of a plate of known speed what is the equivalent exposure. Thus, with the instrument as described above, it has been found that an actual exposure of 340 secs. gave exactly the same result as an effective exposure to a standard candle of 40 secs.

For true speed reading the emulsion must be coated on plate glass; the plates should be backed, and the strips to be tested should be cut out of the middle of a whole-plate. The glass generally used for plates is so uneven as to give rise to considerable errors, and if not backed, halation occurs; the backing should be black and not red.

The Photometer.—This instrument is used for measuring the densities of the plates. The simplest type, and the one used by Hurter and Driffield, was a modification of the Bunsen grease-spot photometer; its main fault is that the two spots that have to be compared are not contiguous. The instrument consists essentially of a box with one side open and the edges splayed out to protect the operator from the light, whilst measuring the densities. E shows a plan. The case may be made of wood, but those parts near the lamps should be of asbestos millboard, inside which should be two sheets of copper or zinc perfectly plane and blackened, as should be the whole of the inside of the box. At each end in the centre of the sides is a hole 6 mm. in diameter; between these holes should be a plane

block of wood, with either a rack or a smooth piece of metal on top; and the small box shown should be provided with a pinion or small rollers so that it may run easily to and fro. In both diaphragms should be placed either ground glass or preferably opal, just behind the copper plate. To the centre of the little box should be affixed a pointer passing along a graduated scale, fastened to the bed on which the box moves. The little box is of light wood with two mirrors at the back placed at a low angle, whilst between them is the grease spot, which can be fixed to a piece of stout card with a hole cut in it, or between two thicknesses of card. Some instruments are not provided with the lens and eyetube; these are to be preferred, although far better still is a low-angled bi-prism, which brings the images of the spots into juxtaposition.

The making of a grease spot is by no means an easy matter at first, but as the materials are nothing but a hard carriage candle, a big darning needle and a spirit flame or gas, plus the paper, it is merely a question of practice to produce a large number of spots, the best of which can then be chosen. The paper should be thin, with a matt surface, and not too hard, and it should be cut into 1-in. discs, which should then be placed round the candle, the eye end of the darning needle made hot and placed as nearly as possible in the centre of the paper; the heat melts the wax, which is absorbed by the paper, and forms a semi-translucent spot, preferably not more than 1 mm. in diameter. Make a number, and choose the best and most regular. A very translucent spot enables one to read very high densities, but it is not so sensitive. After using the instrument for a short time, it will soon be found whether the grease spot chosen is satisfactory or not, for as the highest density that is usually required is about 3.60 this should be the limit of sensitiveness required. The chosen spot should be placed between two thin opaque cards, with a $\frac{3}{8}$ -in. hole cut in them, and the spot should occupy the centre of this aperture. The cards may be slid into the little box as shown at E, through the top. The box should measure about 2 in. by $1\frac{1}{2}$ in., with $\frac{3}{8}$ -in. holes in the sides. These holes, the grease spot and the holes in the sides of the photometer box itself, must be absolutely axial one with another.

At the left hand of the instrument is a couple of weak brass clips, fastened to the side to hold the negative to be measured against the aperture. At this side, also, is a small door, on the inside of which is a mirror that reflects the light on to the scale. At the right hand of the instrument is a circular plate pierced with openings which can be rotated in front of the aperture exactly like the old wheel diaphragms of lenses so as to reduce the luminosity of the one light, as this considerably facilitates the readings.

With the grease spot photometer, the distance between the two diaphragms at the end of the scale bed must be 12 in.; with the two Lummer-Brodhun rhombs and the Martens heads, described below, this distance must be increased to 20 in. To mark the scale (preferably of ivory or celluloid), the following formula is used: let z = half the distance between the two diaphragms, D = the density, and x = the distance

the grease spot is shifted to obtain equality of illumination, then

$$D = \log \left(\frac{z + x}{z - x} \right)^2$$

Example: let the distance between the two diaphragms = 20 ins., then $z = 10$, then D for any distance, say 5.6 in., will be

$$D = \log \left(\frac{10 + 5.6}{10 - 5.6} \right)^2 = \left(\frac{15.6}{4.4} \right)^2$$

$$\log \text{ of } 15.6 = 1.193125$$

$$\log \text{ of } 4.4 = .643453$$

$$.549672$$

$$\times 2$$

$$1.099344$$

which is the density required.

In order to save calculations, the following table gives the distances and the corresponding densities:—

Distance	Density	Distance	Density
$z \times 0.057 =$	0.1	$z \times 0.519 =$	1.0
$z \times 0.114 =$	0.2	$z \times 0.560 =$	1.1
$z \times 0.171 =$	0.3	$z \times 0.599 =$	1.2
$z \times 0.226 =$	0.4	$z \times 0.634 =$	1.3
$z \times 0.280 =$	0.5	$z \times 0.667 =$	1.4
$z \times 0.332 =$	0.6	$z \times 0.698 =$	1.5
$z \times 0.382 =$	0.7	$z \times 0.726 =$	1.6
$z \times 0.430 =$	0.8	$z \times 0.752 =$	1.7
$z \times 0.476 =$	0.9	$z \times 0.776 =$	1.8

To use the table, z is merely the exact centre of the scale, and if this is 6 in. or 10 in. from either diaphragm, then the above distances must be merely multiplied by 6 or 10, and marked off on the scale in the corresponding densities. Each division or density space should be further divided into four equal parts, which enables one to read the densities to every .25.

It has been assumed above that the centre point is marked zero or 0; obviously, then, the readings to the right will be *minus* readings, and those to the left *plus* readings. This leads to trouble and confusion, and it is better to mark the extreme right of the scale zero, and the numbers will then run up to 3.60, the centre being 1.8. This enables the densities to be read off direct.

The diaphragms at each end of the photometer box should be of equal diameter; when the lights are equal the zero point will fall in the centre. It is preferable, however, to reduce the right-hand light by a diaphragm of smaller diameter or by increasing the distance of the light. In any case, it is advisable to provide extra diaphragms on the right-hand side so as to be able to reduce the light here for reading high densities. It will be found convenient to reduce the light to densities of .5, 1.0, and 1.5 respectively. To find the diameter of the smaller apertures, square the logarithm of the diameter of the original aperture, deduct .5, 1.0, and 1.5 respectively, and divide the remainder by 2, when the quotients will be the logarithms of the diameters of the new diaphragms. For instance, suppose that the original diaphragms are 6 mm. in diameter, then

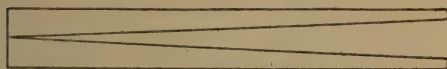
$$6^2 = 36$$

$$\log 36 = 1.556302$$

$$\text{and } 1.556302 - 0.5 = 1.056302$$

$$1.056302 \div 2 = 0.528151$$

which is the logarithm of 3.374, the diameter of the new diaphragm, which will reduce the densities by 0.5. In exactly the same way we find that the diameters for 1.0 and 1.5 would be 1.897 and 1.06 mm. In any case, it is advisable



F. Wedge

to test these diaphragms by actual readings, the mean of six readings being taken.

Instead of circular apertures, rectangular ones may be used, and a square of about .203 mm. is convenient. As the density patches on the plate measure approximately 2.5×1 cm., it is obvious that the diaphragms may be considerably larger than stated above, but it is convenient to keep them small, as this enables one to shift the plate about over the aperture and thus avoid any local defect, such as a pinhole or black spot.

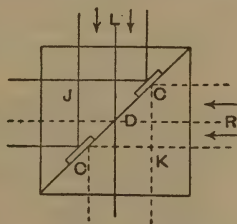
If rectangular apertures are used, then a strip of metal, 10 in. long, with a wedge cut out as shown at F, will be required. The wedge should taper from $\frac{1}{2}$ in. to a point, and this can be marked with the densities according to the following rule:—

$D = \log.$ of wedge length — distance from apex.

Far superior to the grease spot in accuracy of reading are the photometer heads of Lummer and Brodhun and of Martens. The former is made in two forms, one of which gives an image similar to the grease spot G, the second kind being still more sensitive, as, with experience, readings to about 0.5 per cent. or even to 0.22 per cent. are possible. Instead of the grease spot two right-angled prisms are used (J and K in diagram H). J has a small ring CC etched out, whilst the central circle is left polished; the other prism K is placed in contact with J, and the passage of the light is shown by the lines and arrows; at D, where there is optical contact, the light from the source at R passes straight through the prism, but at C, where it meets with a thin film of air, it undergoes total reflection and forms the outer circle, shown grey in G. Exactly in the same



G. Grease-spot Image

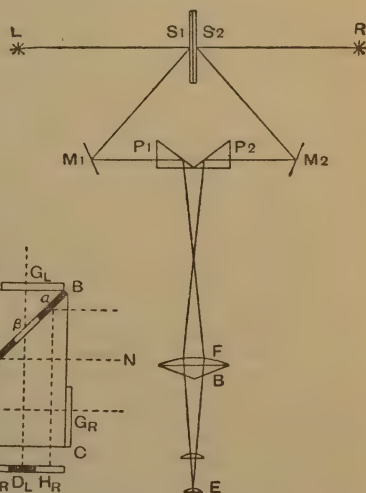


H. Photometer Head having two Right-angled Prisms

way, the light from I, meets at C a film of air, is reflected at right angles, and is lost in the mounting of the prism, whilst the central beam passes straight through to the eyepiece.

In the still more delicate instrument, the rhomb, shown at V in diagram I, is used. The light proceeds from two sources M and N; two

right-angled prisms are placed with their hypotenuses together. On one of the prisms the surfaces α , γ , and ϵ are etched to a matt surface; at β , δ , and ζ the surfaces are left polished, and are in optical contact. At GR and GI are two small plates of glass which reduce the light about 8 per cent. The field, as seen in the eyepiece, presents the appearance of Z, and if the intensity of the light on DB and BC is the same, HR and HI, are equally bright, and the fields DR and DC are also equally bright but stand out darker than the background. If, on the other hand, the intensity on BC is greater than on DB, the contrasts in the right half of the field of view are increased and those in the left-hand field are lowered. With both these heads, the operator sees the field of view not at right angles to the scale but at about an angle of 45° , but the makers, Schmidt and Haensch, of Berlin, supply a form of direct-vision head.



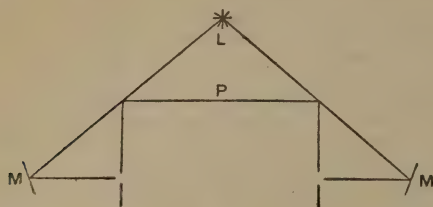
I. Lummer & Brodhun J. Martens's Photometer Head

Martens's photometer head, made by the same firm, is shown in diagram form by J; in this, the light from the two sources I, and R falls upon two plaster-of-paris screens S_1 S_2 , and is thence reflected to the two mirrors M_1 M_2 , and the two right-angled prisms P_1 P_2 . There is total reflection to the plano-convex lens R, to which is cemented the bi-prism B, by which images are brought into juxtaposition in the eyepiece E.

In the photometer as suggested by Hurter and Driffeld two oil lamps with flat flames, fed from a common oil receptacle, were used, but unless the lamps are outside the photometer room the heat is too great to be comfortable. With electric light the trouble of the heat is more easily avoided, but accurate readings cannot be obtained with a lot of stray light about the room. In any case the use of two separate lights introduces an element of uncertainty through the variation of the lights themselves, and it is better to use one light, such as a 150 candle-power electric or powerful incandescent gas, and reflect it by means of mirrors through diaphragms as

shown at K, in which L is the light, MM the mirrors, and P the photometer.

A simple and ingenious photometer has been devised by Chapman Jones, called by him an opacity meter, and illustrated and described



K. Arrangement for Photometer with only One Light

under its own heading. In this case the screen is opal glass, against which the plate is clipped; the scale may also be in opacity logarithms or densities. Another instrument, introduced by F. F. Renwick, is used for measuring densities, and is a simple form of comparison photometer, in which a uniformly and strongly illuminated area of fine ground glass is viewed through two small square apertures close together in the front of the instrument, one of which is covered by the density to be measured, and the other by a sliding wedge of neutral tinted glass compensated to give a uniform field by a very thin wedge of the same kind and angle. The two apertures are brought into contact by means of an Albrecht rhomb.

Spectrophotometers are numerous and costly. Briefly the light passes through two apertures, the two beams split up into contiguous spectra, and the luminosity of one reduced to that passing through the density to be measured, by means of Nicol prisms. An instrument that has been highly recommended is the Martens's polarisation photometer or "absorptionsmesser," made by Schmidt and Haensch, which is shown at L. The quality of the fields or the zero point is first obtained by revolving the upper prism A; then the reading of the angle is taken, the negative strip B is then placed on the bed on an opal plate (not shown), A revolved till even illumination is again obtained, and the reading taken. The density is $\log \tan^2 \theta' - \log \tan^2 \theta$, in which θ' is the angle with the negative plate and θ the angle without the negative. The log tan can be obtained from any book of mathematical tables.

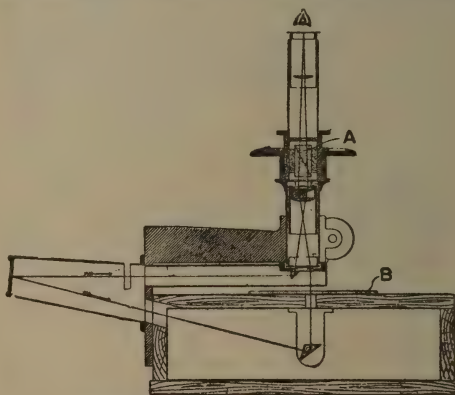
Such calculations may seem formidable, but they consist really of reading logarithms from an ordinary book of mathematical tables, and the application of the three simple rules of arithmetic.

Development of the Plate.—The plate strips having been exposed, the next step is their development. Originally, Hurter and Driffield suggested the use of ferrous oxalate as the standard developer, but, recognising that this was no longer in practical use, they adopted a non-staining pyro-soda developer, and this should be adopted now as the standard. The formula is:—

Pyrogallol	56 grs.	8 g.
Sodium sulphite cryst.	280 "	40 "
Sodium carb., pure	280 "	40 "
Distilled water to	16 oz.	1,000 ccs.

This will not keep as one solution, but it can be easily prepared in two-solution form, the pyro and sulphite being dissolved in half the water and the carbonate in the remainder, and the two mixed just before use. A constant temperature must be maintained, and 65° F. (18° C.) may be adopted. Not only the developer, but the dish, the measures, and the plate itself, should be at this temperature. It is possible to use a properly constructed thermostat, but equally satisfactory results can be obtained by using a zinc or copper tank sufficiently large to contain dish, measures, and developer. Diagrams M and N represent a tank used by the author. The zinc tank holds half a gallon of water; the dish made of copper is provided with projecting edges E, which are turned over so as to fit loosely on the edges of the tank. Sufficient room is provided in the tank to allow of the measure and the bottle of developer being placed in it to warm up. The water is heated to about 68° or 75° F., according to the season of the year, and the dish and the measures cool it down to 65° F. in about ten minutes. After exposure, the plate is also placed in the dish, covered with the opaque cover, and left for two or three minutes to warm up. The developer is flowed over the plate, the opaque cover replaced, and the dish gently rocked. There is not the slightest advantage in looking at the plate, and the opaque cover prevents any possible light fog. The duration of development is a matter of choice; if too short the resulting densities are thin generally and difficult to measure, whilst if too long the higher densities are beyond the power of the photometer. For the above pyro-soda developer four minutes will be found to be about correct.

There is one point which is of considerable practical importance, and that is the use of two strips for speed determinations. For this reason it is strongly advised to cut the plate into two lengthwise before exposure. A fixed frame can be made with a guide for the diamond, and the



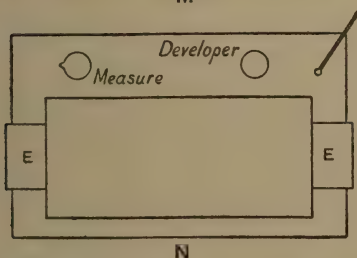
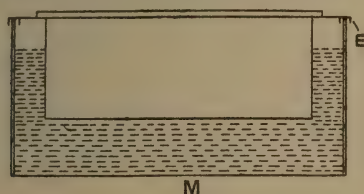
L. Martens's Polarisation Photometer

plate may be cut and put in the dark-slide and exposed as one. This will obviously yield two strips, the second of which should be developed for double the time of the first; that is, eight minutes with pyro-soda. Of course, any other developer may be adopted as the standard, but then it is a question as to whether the system

can be correctly termed that of Hurter and Driffield. It has been repeatedly stated that certain developers will enable exposures to be reduced to one-third, one-fourth, and so on; this is tantamount to saying that a particular developer will treble, quadruple, or otherwise increase the speed of the plate. This question has been examined by Sheppard and Mees, and they found that there were practically two classes of plates on the market—one that gives the same speed with all developers, and the other with which the speed is increased by using an organic developer instead of ferrous oxalate. They found that practically the second class of plate showed an increase of speed with organic developers over ferrous oxalate of 1.75:1.

Whatever be the developer adopted, it is important that no bromide be used.

As soon as development is finished the plate should be thoroughly fixed in an acid fixing bath, washed, immersed for a minute or two in a 5 per cent. solution of hydrochloric acid, rinsed under the tap, and the film gently rubbed with a



M. and N. Wall's Developing Tank

wet pledget of cotton wool and put away to dry. As soon as dry the back of the glass should be well cleaned with cotton-wool or a rag, and the dividing lines between the densities marked with a pen and ink, as this considerably facilitates the adjustment of the strip in the photometer.

Reading the densities.—The first thing to do is to calibrate the photometer. For accurate reading it is essential to work in a dark-room, and at least five minutes should be allowed to elapse before attempting to read so as to allow the retina to recover from the fatigue caused by bright light. To calibrate the photometer—that is to say, to find the zero—the spots or patches formed in the photometer box are compared, and the box shifted to right or left till they are of equal luminosity. At least three readings should be taken or six for preference, and the mean of these adopted.

The strip of plate should be thoroughly warmed, as this prevents the condensation of moisture on it, which is apt to occur if the heat from the lamps is great. The plate should then be slipped into the spring catch at the left hand

of the box or in its proper position and adjusted till the fog strip is over the aperture. The fog strip is that portion of the plate protected from any light action by the opaque card at the edges of the dark slide, and the reading of this is the density due to the glass, the gelatine and any fog inherent in the emulsion itself. Then the greatest density should be read, and all the others in turn, each being jotted down in a notebook kept for the special purpose. For the sake of convenience the decimal points may be neglected whilst reading, as they can always be inserted afterwards.

The following is an example of the reading of a plate developed for three minutes with a metol-hydroquinone developer at 65° F. (18° C.) :—

Plate A

Zero point, .10; fog point, .35; actual fog =
 $.35 - .10 = .25$

Exposure C.M.S.	Reading	True density = Reading - (zero + fog = .35)
40	2.65	2.30
20	2.67	2.32
10	2.65	2.30
5	2.55	2.20
2.5	2.35	2.00
1.25	1.90	1.55
.625	1.45	1.10
.312	1.05	.80
.156	.75	.40

Another plate gave the following readings :—

Plate B

Zero point, .15; fog point, .30; actual fog =
 $.30 - .15 = .15$.

Exposure C.M.S.	Reading	True density = Reading - (zero + fog = .30)
40	2.80	2.50
20	2.42	2.12
10	1.90	1.60
5	1.70	1.40
2.5	1.32	1.02
1.25	.98	.68
.625	.60	.30
.312	.40	.10
.156	.34	.04

A third plate gave the following :—

Plate C

Zero point, .10; fog point, .55; actual fog =
 $.55 - .10 = .45$.

Exposure C.M.S.	Reading	True density = Reading - (zero + fog = .55)
40	1.95	1.40
20	1.90	1.35
10	1.77	1.22
5	1.57	1.02
2.5	1.39	.84
1.25	1.20	.65
.625	.85	.30
.312	.65	.10
.156	.59	.04

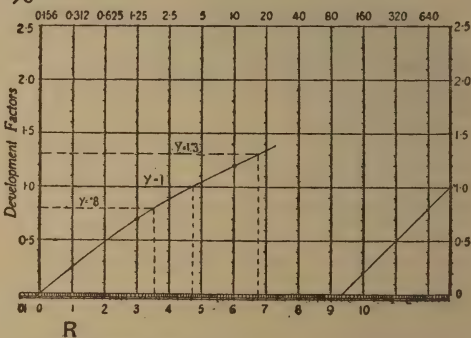
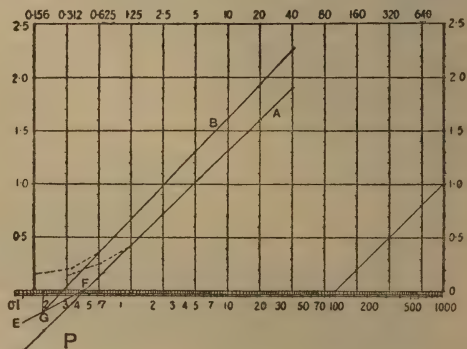
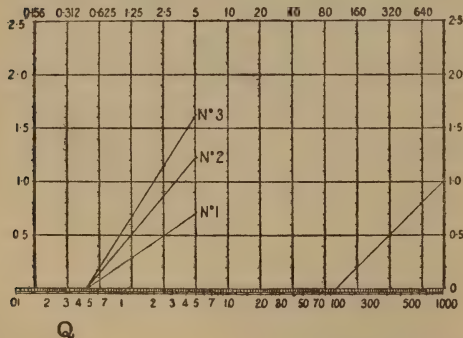
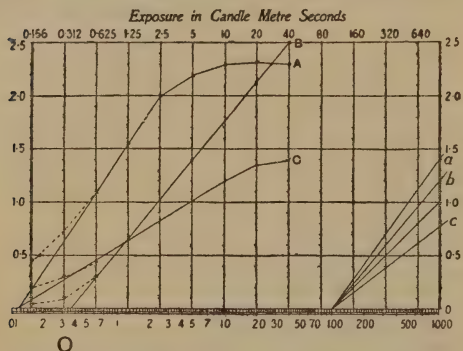
If it is impossible to obtain equality of the fields with the highest densities, the luminosity of the right-hand side can be reduced by bringing

one of the smaller diaphragms into position and adding its value to the density reading. Thus, if with the largest supplementary diaphragm the density is found to be 3.45, the real density will be $3.45 + .5$ (the value of the supplementary diaphragm) = 3.95. It may be as well to point out that the accuracy of such high density readings as this is very doubtful. Having jotted down the readings, first the zero point is deducted from the fog, then the fog and zero are deducted from all the readings in turn, and the true densities thus found. The densities are then plotted out on charts, and the points joined up by holding a flexible rule along them and drawing pencil lines. The charts (see O, P, Q, and R) can be drawn on paper or scratched on a

bottom of the chart, as shown in O by the dotted lines; this gives the "inertia" of the plate.

The "inertia" of the plate is its slowness, and the speed of the plate is found by dividing 34 by the inertia. Frequently the inertia is expressed in logarithms, and is then called log I.

Turning to chart O, consider the three plates. First with regard to A, the straight line portion obviously lies between 2.5 and 0.312 C.M.S. or candle-metre-seconds. The density corresponding to 0.156 is too high, and this is the period of under exposure. From 2.5 to 5 C.M.S. the curve begins to flatten, and had the exposure been increased it would have turned right down again. This flattened portion from 2.5 to 40 C.M.S. is the period of over-exposure. The point



O, P, Q and R. Charts of Plate Densities, etc.

plate. The inertia scale is merely the log scale of an ordinary slide rule repeated four times instead of twice. At the points 0.156, 0.312, 0.625, 1.25, etc., are drawn the vertical equidistant exposure lines, and the exposures can be written at the top. The "density" and "development factor" scales on the right and left respectively are exactly similar, and the distance from 0 to 1.0 should exactly correspond with the length of the inertia scale from 10 to 100 or 100 to 1,000. From the 100 point on the inertia scale draw the heavy line to 1.0 on the development factor scale. Having marked the densities corresponding to the exposures and joined up the points by straight lines, the characteristic curve of the plate is obtained. The speed is found as follows: by means of a transparent celluloid ruler or a piece of black thread find that portion that lies on a straight line and continue it till it cut the inertia scale at the

bottom of the chart, as shown in O by the dotted lines; this gives the "inertia" of the plate.

In plate B there is a totally different character; here the straight portion extends from 0.625 to 40 C.M.S. As a matter of fact, it extended to 80 C.M.S., although this was not charted. The inertia is obviously 0.36, and the speed consequently $34 \div 0.36 = 95$ H. and D. This would be an excellent landscape plate with considerable latitude of exposure, as the straight portion extends from 0.36 to 40 C.M.S., or the range is 1:111. Plate A, on the other hand, has only a range of 1:25.

Plate C is peculiar, as it will be seen that the curve begins to fall off at 10 C.M.S.; the highest density is comparatively low, 1.40 for 40 C.M.S., yet the inertia is 0.15 and the speed therefore 226 H. and D.

It will be noted that the reading of plate A



BY H. ESSENHIGH CORKE, F.R.P.S.

FIRELIGHT EFFECT

at 10 C.M.S. was 1.60, obviously too low, as the straight line cuts at 1.76; here there is probably some little error in the plate coating which has given this low reading. The dotted portion of the curve is known as the "period of under-exposure," the straight portion that of "correct exposure," whilst the reverse or turning over of the curve as in A (diagram O) is known as "the period of over-exposure," the whole forming the characteristic curve of the plate.

The latitude of a plate can be easily calculated if the range of light intensities in a subject is known. For instance, with a landscape the range is usually about 1:30, and with plate B the latitude would be therefore $111 \div 30 = 3.7$, so that it would be permissible to give an exposure from 1 to $3\frac{1}{2}$ seconds and yet obtain a good negative.

Sheppard and Mees have given a mathematical expression and formula for finding the latitude of the plate, which they define as its opacity for blue violet light. They also suggest a much simpler method, which is to expose another plate of known inertia underneath the plate of which it is desired to know the latitude, and measure the apparent inertia; the difference between the known inertia and that obtained will be the latitude of the plate.

It will be noted that on the right-hand side of the chart O are three lines *a*, *b*, *c*, drawn from the 100 point of the inertia scale and parallel with the straight portion of the curves A, B, and C. When a line thus drawn coincides with the line drawn from 100 to 1, which is obviously at an angle of 45° , the negative is correct as regards the rendering of the tones of the subject. If this development factor or gamma λ , as it is called, is above 1, as with plates A and B, the contrasts of the subject are increased; whereas if below, as with C, the contrasts of the subject are reduced.

The development factor or λ is important, and may be calculated in various ways, as will be seen later.

It has already been advised that two strips should be exposed and developed together, the one for double the time of the other. This enables the operator to determine whether the plate contains free bromide, as this is sometimes added to the emulsion by the manufacturer, either in the shape of potassium or ammonium bromide or hydrobromic acid, to keep the plate clean. Free bromide in the film or added to the developer actually lowers the speed of the plate with a given time of development. If, then, on reading the second strip, developed for double the time, it is found to have a different inertia, the true speed of the plate can be found by charting the two readings and continuing the straight portion of the curve of the strip developed for the shorter time, which we will call A, to a point C below the inertia scale P. C may be any convenient point. Then from C draw the ordinate CD to the inertia scale and bisect this at E, connect E with F the inertia of A, and having charted B, the plate developed for double the time, continue the straight portion till it cuts EF at G; then an ordinate from G to the inertia scale gives the true inertia of the plate. In P this operation is shown, and the inertia of A = .46, that of B = .29, whilst the true inertia is .185. Bromide added to the developer increases the inertia in

the same way, though with continued development the true inertia is obtained.

The duration of development may be fixed at any convenient length, the only consideration limiting it being the ease of reading the densities. Prolonged development has no effect upon the inertia or speed of the plate. The sole result of shorter or longer development is the attainment of a lesser or greater development factor, provided the emulsion and developer contain no free bromide. This is clearly seen from the accompanying table and chart Q, the former being taken from an early issue of the *Photo-Miniature* by Driffield.

	1	2	3	4	5
	Exposure C.M.S.	Density	Density ratio	Opacity	Opacity ratio
Strip No. 1 developed 4 mins.	1.25 2.5 5.0	.310 .520 .725	1.0 1.67 2.33	2.04 3.31 5.30	1.0 1.62 2.59
Strip No. 2 developed 8 mins.	1.25 2.5 5.0	.530 .905 1.235	1.0 1.70 2.33	3.38 8.03 17.18	1.0 2.37 5.08
Strip No. 3 developed 12 mins.	1.25 2.5 5.0	.695 1.140 1.625	1.0 1.64 2.33	4.95 13.80 42.17	1.0 2.78 8.51

In column 1 are the exposures, in column 2 the densities, in column 3 the ratios between the densities, whilst in column 4 are the opacities, and in column 5 the ratios between the opacities.

As all the strips were exposed at once there is no question of variation here, but varying the length of development has produced densities which vary very widely, the increase being as much as 2:34. The densities given by Driffield have been charted, and it will be at once seen that the inertia obtained with all three strips is the same, but the gammas are very different. The fact of the inertias being the same proves that prolonged development will not "fetch more out of a plate," and the variation of gamma proves that by reducing or prolonging the time of development the photographer is in a position to alter the character of his prints by using a higher or lower gamma. For instance, assuming that a negative was developed to a gamma of .7 as strip 1, it is obvious that the negative would be what is generally termed "thin," and therefore probably most suitable for gaslight paper. If it had a $\lambda = 1.14$ as strip 2, then it would be much denser, and probably suitable for P.O.P.; whereas if it had a $\lambda = 1.5$ as No. 3, then it would be dense and suitable for rapid bromide paper. In the last case most probably the lower tones—that is, the shadows—would be much blocked up by the time the high lights were sufficiently printed, whilst in the first case the high lights would be printed out before the shadows had obtained sufficient depth.

The Development Factor.—The development factor or gamma has already been defined as the degree of contrast in the negative. This is dependent in part on the plate and also on the

duration of development. Gamma may be found graphically as already described, or W. B. Ferguson's method may be adopted, this being to multiply the means of the highest densities by 3.3.

For instance, taking plate B (chart O), the upper densities and differences are:—

Densities	Differences	
2.50	>	3.8
2.12	>	3.6
1.76	>	3.6
1.40	>	3.5
1.05	>	3.5
mean .3625		

Then $.3625 \times 3.3 = 1.207$, which coincides with that found graphically.

The gammas usually adopted in practice are .8 for portraits, 1.0 for architecture, and 1.3 for landscapes. To find the necessary time to develop to any given gamma, plot out on a chart the gammas obtained by developing the two strips or by Ferguson's calculation, this chart being exactly the same as our speed chart, only the development factors are written on the left-hand side and the time of development at the bottom instead of the inertia scale (see R). Suppose that we obtain for the A strip $\lambda = .7$ with three minutes' development, and for B $\lambda = 1.2$ with six minutes' development, plot these, and draw a curve connecting these points with the zero point (see R). Then, to find the necessary time to obtain any given gamma, draw a straight line from the required development factor and another at right angles to it till it cuts the time scale at the bottom, when, as will be seen from R, the times would be 3.6 minutes for $\gamma = .8$, 4.6 minutes for $\gamma = 1$, and 7 minutes for $\gamma = 1.3$.

A moment's consideration will show that there must be a limit to the density obtainable on a plate, and this is termed D_{∞} , or gamma infinity γ_{∞} .

The Velocity Constant, or κ .—The velocity of development is the speed with which a plate develops; usually ferrous oxalate is used as the developer for photochemical investigations, but pyro-soda or other organic developer may be used instead. The mathematical expression for this factor is

$$\kappa = \frac{1}{t} \log \frac{D_{\infty}}{D_{\infty} - D}$$

or

$$\kappa = \frac{1}{t} \log_e \frac{\gamma_1}{\gamma_2 - \gamma_1}$$

In order to save calculation, Sheppard and Mees have given a table (reproduced in the next column) which enables κ to be found with very little trouble.

An example will make the use of this table clear. Two strips are developed, the first say for four minutes, and the second for double that time—that is, eight minutes. The gammas are found, as previously described, and assuming them to be 1.5 for the strip developed for the shorter time and 2.1 for that developed for double the time, then

$$2.7 + 1.5 = 1.8$$

In the second column of the table, headed

κ	$\frac{\gamma_2}{\gamma_1}$	$\Delta \text{ for } \Delta$ 0.001 in κ	κ	$\frac{\gamma_2}{\gamma_1}$	$\Delta \text{ for } \Delta$ 0.001 in κ
0.005	1.977	0.0050	0.205	1.358	0.0018
0.010	1.952	0.0048	0.210	1.349	0.0016
0.015	1.928	0.0050	0.215	1.341	0.0018
0.020	1.903	0.0046	0.220	1.332	0.0016
0.025	1.880	0.0044	0.225	1.324	0.0016
0.030	1.858	0.0042	0.230	1.316	0.0016
0.035	1.837	0.0040	0.235	1.308	0.0014
0.040	1.817	0.0040	0.240	1.301	0.0014
0.045	1.797	0.0038	0.245	1.294	0.0016
0.050	1.778	0.0038	0.250	1.286	0.0016
0.055	1.759	0.0036	0.255	1.278	0.0014
0.060	1.741	0.0034	0.260	1.271	0.0014
0.065	1.724	0.0034	0.265	1.264	0.0014
0.070	1.717	0.0032	0.270	1.257	0.0012
0.075	1.691	0.0032	0.275	1.251	0.0012
0.080	1.675	0.0030	0.280	1.245	0.0012
0.085	1.660	0.0032	0.285	1.239	0.0012
0.090	1.644	0.0032	0.290	1.233	0.0012
0.095	1.628	0.0032	0.295	1.227	0.0012
0.100	1.612	0.0032	0.300	1.221	0.0010
0.105	1.596	0.0032	0.305	1.216	0.0012
0.110	1.580	0.0030	0.310	1.210	0.0010
0.115	1.565	0.0028	0.315	1.205	0.0010
0.120	1.551	0.0028	0.320	1.200	0.0010
0.125	1.537	0.0028	0.325	1.195	0.0008
0.130	1.523	0.0026	0.330	1.191	0.0010
0.135	1.510	0.0028	0.335	1.186	0.0008
0.140	1.496	0.0024	0.340	1.182	0.0008
0.145	1.484	0.0024	0.345	1.178	0.0008
0.150	1.472	0.0024	0.350	1.174	0.0010
0.155	1.460	0.0024	0.355	1.169	0.0008
0.160	1.448	0.0022	0.360	1.165	0.0008
0.165	1.437	0.0022	0.365	1.161	0.0008
0.170	1.426	0.0020	0.370	1.157	0.0006
0.175	1.415	0.0018	0.375	1.154	0.0008
0.180	1.405	0.0018	0.380	1.150	0.0006
0.185	1.396	0.0020	0.385	1.147	0.0008
0.190	1.387	0.0020	0.390	1.143	0.0008
0.195	1.377	0.0018	0.395	1.139	0.0006
0.200	1.368	0.0020	0.400	1.136	0.0006

$\frac{\gamma_2}{\gamma_1}$ we find 1.40, and against this in column 1 γ_1 under κ we find .180, but this is for 5 minutes.

$$\therefore (5 + 4) \times .180 = .225 = \kappa.$$

Column 3, headed Δ for Δ .001 in κ , is used as follows: supposing $t \frac{\gamma_2}{\gamma_1} = 1.373$, the nearest number to this is 1.377, and Δ or the difference = $1.377 - 1.373 = .004$, then .004 + .0018, from the third column = 2.2, therefore we take the κ of 1.377 and add .0022, thus—

$$.195 + .0022 = .197.$$

This table does not apply for any developer with a Watkins factor of over 15; if γ_2 is 1.8 times greater than γ_1 , two other strips must be developed for twice as long as before.

We may now proceed to find γ_{∞} . The formula for this is

$$\gamma_{\infty} = \frac{\gamma_1}{1 - e^{-\kappa t_1}} \text{ or } \frac{\gamma_2}{1 - e^{-\kappa t_2}}$$

In order to save calculation, Sheppard and Mees have given the table on the opposite page.

An example will make the use of this table clear. The two strips having been read and γ_1 and γ_2 having been found, κ is calculated as just described, and we found in the case assumed $\kappa = .225$, then $\kappa t_1 = .225 \times 2 = .450$, in the second column headed $1 - e^{-\kappa t}$ against this we find .3617, then

$$\gamma_{\infty} = 1.5 \div .3617 = 4.14.$$

The higher the gamma infinity the more a plate may be forced in development, and for very fast

kt	$1-e-kt$	Δ for 0.01 in kt	kt	$1-e-kt$	Δ for 0.01 in kt
0.000	0.0000		2.000	0.8647	
0.025	0.02		2.025	0.8660	
0.050	0.046	0.0095	2.050	0.8712	0.0013
0.075	0.073		2.075	0.8744	
0.100	0.0952		2.100	0.8776	
0.125	0.1174	0.0086	2.125	0.8805	0.0012
0.150	0.1387		2.150	0.8834	
0.175	0.1600		2.175	0.8863	
0.200	0.1813		2.200	0.8892	
0.225	0.2028	0.0077	2.225	0.8919	0.00105
0.250	0.2252		2.250	0.8945	
0.275	0.2422		2.275	0.8971	
0.300	0.2592		2.300	0.8997	
0.325	0.2769	0.0071	2.325	0.9021	0.00096
0.350	0.2945		2.350	0.9045	
0.375	0.3121		2.375	0.9069	
0.400	0.3297		2.400	0.9093	
0.425	0.3458	0.0064	2.425	0.9113	0.00086
0.450	0.3617		2.450	0.9135	
0.475	0.3776		2.475	0.9157	
0.500	0.3935		2.500	0.9179	
0.525	0.4085	0.0057	2.525	0.9197	0.00078
0.550	0.4234		2.550	0.9217	
0.575	0.4373		2.575	0.9237	
0.600	0.4512		2.600	0.9257	
0.625	0.4641	0.0052	2.625	0.9274	0.00071
0.650	0.4772		2.650	0.9292	
0.675	0.4903		2.675	0.9310	
0.700	0.5034		2.700	0.9328	
0.725	0.5158	0.0047	2.725	0.9344	0.00064
0.750	0.5281		2.750	0.9360	
0.775	0.5394		2.775	0.9376	
0.800	0.5507		2.800	0.9392	
0.825	0.5613	0.0042	2.825	0.9408	0.00058
0.850	0.5714		2.850	0.9412	
0.875	0.5827		2.875	0.9426	
0.900	0.5934		2.900	0.9450	
0.925	0.6031	0.0038	2.925	0.9463	0.00052
0.950	0.6128		2.950	0.9476	
0.975	0.6225		2.975	0.9489	
1.000	0.6322		3.000	0.9502	
1.025	0.6485	0.0034	3.025	0.9513	0.00047
1.050	0.6547		3.050	0.9525	
1.075	0.6609		3.075	0.9537	
1.100	0.6671		3.100	0.9549	
1.125	0.6741	0.0032	3.125	0.9559	0.00043
1.150	0.6830		3.150	0.9570	
1.175	0.6909		3.175	0.9581	
1.200	0.6988		3.200	0.9592	
1.225	0.7059	0.0029	3.225	0.9601	0.00039
1.250	0.7131		3.250	0.9611	
1.275	0.7203		3.275	0.9621	
1.300	0.7275		3.300	0.9631	
1.325	0.7339	0.0026	3.325	0.9639	0.00036
1.350	0.7403		3.350	0.9648	
1.375	0.7469		3.375	0.9657	
1.400	0.7534		3.400	0.9666	
1.425	0.7592	0.0024	3.425	0.9674	0.00032
1.450	0.7651		3.450	0.9682	
1.475	0.7710		3.475	0.9690	
1.500	0.7769		3.500	0.9698	
1.525	0.7822	0.0022	3.525	0.9706	0.00029
1.550	0.7875		3.550	0.9713	
1.575	0.7928		3.575	0.9720	
1.600	0.7981		3.600	0.9727	
1.625	0.8029	0.0021	3.625	0.9732	0.00026
1.650	0.8077		3.650	0.9739	
1.675	0.8125		3.675	0.9746	
1.700	0.8173		3.700	0.9753	
1.725	0.8215	0.0017	3.725	0.9758	0.00023
1.750	0.8259		3.750	0.9764	
1.775	0.8303		3.775	0.9770	
1.800	0.8347		3.800	0.9776	
1.825	0.8387	0.0016	3.825	0.9780	0.00022
1.850	0.8426		3.850	0.9786	
1.875	0.8465		3.875	0.9792	
1.900	0.8504		3.900	0.9798	
1.925	0.8539	0.0014	3.925	0.9802	0.00019
1.950	0.8575		3.950	0.9807	
1.975	0.8611		3.975	0.9812	
			4.000	0.9817	

shutter work—such as focal plane work, where practically the whole of the exposure falls in the period of under-exposure—a plate with a high γ will give as good results as a very fast plate.

Extreme care must be used in employing the foregoing tables for finding γ , as a very small error will make a considerable difference in the result. Almost as satisfactory results may be obtained by adding 1 per cent. of potassium bromide to the developer and continuing development for half an hour, and after reading the strip finding γ graphically by the chart. The quantity of bromide to be used depends upon the plate, the important point is that the plate should be as free from fog as possible, even with the prolonged development. Should the development—thirty minutes—be not long enough, this will be apparent from the inertia obtained from this long development being less than for the same plate without bromide, then the development must be longer still. The effect of bromide in the developer is at first to increase the inertia and decrease γ , but with prolonged development these effects disappear, and both the inertia and γ are the same as if no bromide were used.

The Photometric Constant.—Hurter and Driffield proved that the density was directly proportional to the amount of silver deposited, and this has been termed the photometric constant = P the quantity of silver in grammes per 100 square centimetres. Hurter and Driffield found that this was = .0131, Eder obtained .0103, and Sheppard and Mees found $P = .01031$.

The Watkins and Wynne Plate Speeds.—Whilst the Hurter and Driffield system is generally used for plate testing, there are two other systems of plate speeds which are used with the Watkins and Wynne exposure meters, which are founded upon purely arbitrary standards. As it is often useful to know how to convert the one system into the other, the following rules can be used:—

To convert—

H. and D speed Nos. into Watkins, multiply by 50 and divide by 34; or practically H. and D. $\times 1\frac{1}{2}$.

Watkins P Nos. into H. and D., divide by 50 and multiply by 34; or practically P No. $\times \frac{3}{5}$.

Wynne F Nos. into Watkins, extract the square root and multiply by 6.4.

Wynne F Nos. into H. and D., extract the square root and multiply by 7.7.

In order to save trouble, the table on page 484 gives the inertias, the H. and D. Nos., and Watkins and Wynne in parallel columns. The inertias are those marked on the scale of the charts.

SEPARABLE LENS

A lens of which the front and back combinations may be used independently, either alone or in combination with other lenses. Rapid and wide-angle rectilinears, Zeiss VIIa anastigmats, Goerz double anastigmats, and Dallmeyer stigmats may be taken as types of this class; while the Cooke, Tessar, and Aldis lenses belong to the non-separable class.

SEPIA BROMIDES (See "Sulphide Toning," "Blake-Smith Process," and "Alum-'hypo' Toning.")

SEPIA PAPER

A printing paper coated with a compound containing salts of silver and iron; development

INERTIAS AND COMPARATIVE PLATE SPEEDS (See SENSITOMETRY)

Inertias	H. and D. Speed	Watkins P. No.	Wynne F. No.	Inertias	H. and D. Speed	Watkins P. No.	Wynne F. No.	Inertias	H. and D. Speed	Watkins P. No.	Wynne F. No.
34.0	1.0	1.4	7.7	4.2	8.1	11.9	21.9	0.60	56.5	83.0	58.3
32.0	1.062	1.56	7.93	4.0	8.5	12.5	22.4	0.58	58.5	86.0	59.5
30.0	1.13	1.66	8.2	3.8	8.9	13.08	23.0	0.56	61.0	89.7	60.5
28.0	1.225	1.8	8.5	3.6	9.4	13.8	23.6	0.54	63.0	92.6	61.6
26.0	1.307	1.92	8.8	3.4	10.0	14.7	24.3	0.52	65.5	96.3	63.0
24.0	1.35	1.98	8.9	3.2	10.6	15.6	25.0	0.50	68.0	100.0	64.0
22.0	1.54	2.26	9.5	3.0	11.3	16.6	25.2	0.48	72.0	105.0	66.0
20.0	1.7	2.5	10.0	2.9	11.7	17.2	26.3	0.46	74.0	109.0	67.0
19.0	1.79	2.6	10.3	2.8	12.2	17.9	26.9	0.44	77.0	113.0	68.0
18.0	1.88	2.76	10.5	2.7	12.6	18.5	27.6	0.42	82.0	120.0	70.0
17.0	2.0	2.9	10.8	2.6	13.1	19.2	27.9	0.40	85.0	125.0	71.5
16.0	2.12	3.1	11.2	2.5	13.6	20.0	28.4	0.38	89.0	131.0	73.3
15.0	2.26	3.3	11.5	2.4	14.2	20.9	29.0	0.36	95.0	140.0	75.5
14.0	2.42	3.56	12.0	2.3	14.8	21.8	29.6	0.34	100.0	147.3	77.6
13.0	2.53	3.86	12.5	2.2	15.5	22.8	30.3	0.32	105.0	155.0	78.8
12.0	2.8	4.1	13.0	2.1	16.2	23.8	31.0	0.30	113.0	166.0	82.5
11.0	3.1	4.5	13.5	2.0	17.0	25.0	31.7	0.29	117.0	172.0	84.0
10.0	3.4	5.0	14.2	1.9	17.9	26.3	32.5	0.28	121.0	178.0	85.5
9.5	3.55	5.2	14.5	1.8	18.9	27.7	33.5	0.27	126.0	185.0	87.3
9.0	3.7	5.4	14.8	1.7	20.0	29.4	34.7	0.26	131.0	192.0	89.0
8.5	4.0	5.8	15.4	1.6	21.25	31.25	35.8	0.25	136.0	200.0	90.5
8.0	4.25	6.2	15.8	1.5	22.6	33.2	37.0	0.24	141.0	207.0	92.0
7.5	4.45	6.5	16.2	1.4	24.3	35.8	38.2	0.23	148.0	217.0	95.0
7.0	4.85	7.1	17.0	1.3	26.15	38.5	39.7	0.22	154.0	226.0	96.3
6.8	5.0	7.3	17.2	1.2	28.3	41.6	41.3	0.21	162.0	238.0	98.7
6.6	5.15	7.5	17.5	1.1	31.0	45.6	43.2	0.20	170.0	251.0	100.0
6.4	5.30	7.8	17.7	1.0	34.0	50.0	45.25	0.19	179.0	263.0	104.0
6.2	5.47	8.0	18.0	0.95	35.5	52.2	46.3	0.18	189.0	277.0	109.0
6.0	5.66	8.3	18.3	0.90	37.7	55.5	47.7	0.17	200.0	294.0	110.0
5.8	5.85	8.6	18.6	0.85	40.0	58.5	49.0	0.16	215.0	316.0	114.0
5.6	6.1	8.9	19.0	0.80	42.5	62.5	51.8	0.15	227.0	334.0	117.0
5.4	6.3	9.2	19.3	0.75	46.0	67.7	52.6	0.14	242.0	356.0	120.0
5.2	6.5	9.5	19.6	0.70	48.5	71.3	54.0	0.13	262.0	385.0	125.0
5.0	6.8	10.0	20.0	0.68	50.0	73.5	55.0	0.12	283.0	416.0	130.0
4.8	7.1	1.04	20.5	0.66	51.5	75.7	55.7	0.11	319.0	469.0	138.0
4.6	7.4	1.08	20.9	0.64	53.0	78.0	56.5	0.10	340.0	500.0	143.0
4.4	7.7	1.13	21.3	0.62	54.4	80.0	57.2				

being effected with plain water and fixing in a weak "hypo" bath, toning being optional. The finished prints are of a good sepia tone. The Namias process is recommended; for this two solutions for sensitising are required:—

A. Green ferric am-		
monio-citrate	4 oz.	440 g.
Citric acid	1 "	100 ccs.
Distilled water	10 "	1,000 "
B. Silver nitrate	1 oz.	110 g.
Distilled water	4 "	400 ccs.

These are mixed together, made up to 20 oz. or 2,000 ccs., and applied to the paper with a Blanchard or Buckle brush, and then dried; the whole of the operations must be carried out in the dark-room. A second coating is sometimes advisable. The paper is printed in contact with a negative in daylight in the usual way, but not very deeply, because in the washing after printing a slight intensifying action takes place. After about five minutes' washing the print must be fixed for one to two minutes in an 8 per cent. solution of "hypo." The print is finally washed for about twenty minutes and then dried. The print previous to fixing is of an unpleasant yellow colour, but the operation of fixing changes the yellow colour to a good brown, such change being due, it is thought, to slight sulphurisation. If the fixed prints are not of a pleasing colour they may be toned in an alkaline sulphocyanide bath containing 1 gr. of gold chloride and 50 grs. of ammonium sulphocyanide per 5 oz. of water.

SEPIA PLATINOTYPES, OR SEPIATYPE (See "Platinotype Process.")

SERUM PROCESS

An early process (about 1856) for preparing plain paper for printing. The paper was prepared with serum of milk, then salted or sensitised. The prints were of purple tone.

SHADING MEDIUM

A film of gelatine, bearing on its surface a pattern of stipple or line in relief; used in process work, etc. This film is stretched tightly on a wooden frame and backed with celluloid varnish. The surface of the film is inked, and the pattern can then be transferred to any part of a plate or stone requiring shading with stipple or line.

SHADOWGRAPHS

Silhouette photographs have been called shadowgraphs, but the name has been more generally applied to X-ray photographs.

SHAPE, CUTTING (See "Cutting Shape.")

SHAPES OF PHOTOGRAPHS

There is a strong tendency to restrict the shape of a photograph to some form of the rectangle, although an oval, a circle, and even a lunette, may be employed effectively at times. The rounding of two corners to form a "dome," or of four corners to form a "cushion," is still resorted to at times, but it is rarely desirable, and is probably a survival from the days when lenses frequently left the corners of the plate unexposed. The relation between the length and breadth of a rectangle is of distinct importance; a narrow upright panel, for instance, often

emphasises a suggestion of height. But the chief consideration is that the shape shall include only what is necessary to the making of the picture, and it would be distinctly wrong to include blank or uninteresting parts of the print simply to attain a particular proportion in the resulting rectangle.

SHARPNESS

The usual standard of sharpness, or critical definition, is that a point shall be represented by a circle not exceeding $\frac{1}{16}$ of an inch in diameter. This standard is easily attained, and, indeed, is far surpassed. Even at full working aperture lenses of a certain type will give satisfactory sharpness over the whole of the plate they are intended to cover. The focal field being practically a plane, there is no loss of sharpness towards the edges. On the other hand, lenses with a curved focal field will only give general sharpness of definition when a smaller stop is used.

To secure sharpness in every detail of the image the aperture of the lens is reduced until a satisfactory definition results. This may be done either to counteract poor marginal definition, or to secure sharpness in objects situated in different planes. It is desirable in certain cases to vary the degree of sharpness in different parts of the subject, the parts having the greatest sharpness generally being emphasised thereby. In other cases, sharpness is rather a drawback to a pleasing rendering of a subject. To throw the whole out of focus is not a satisfactory method of modifying sharpness; but there are types of lenses with an adjustment by means of which any required degree of softness or diffusion may be secured. Objectionable sharpness may be modified during printing by interposing between negative and paper one or more thicknesses of celluloid (clear or matt), or even by printing from the glass side of the negative. In enlarging, bolting silk is often used for a similar purpose. (See also "Definition.")

SHEATHS

Flat metal cases to hold plates, used in magazine cameras; each exposed plate is caused to fall into the bottom of the camera, leaving the next one in position for exposure. (See also "Magazine Camera.")

SHELLAC (See "Gums and Resins.")

SHELLAC MOUNTANT (See "Mountants.")

SHELLAC VARNISH

A solution of shellac in alcohol is used in process work as an acid resist for backing the plates, or stopping out margins or other parts to be protected from the etching. For 4 oz. of shellac about 6 oz. of methylated spirit is required. Sometimes about 2 drms. of methyl violet dye is added to colour the varnish. Formulæ for shellac varnishes for negatives are given under the heading "Varnishes."

SHINGLE MARKS

Defects met with in the wet-plate (collodion) process, and caused by the presence of water in the collodion, or by excessive coldness of the sensitising bath.

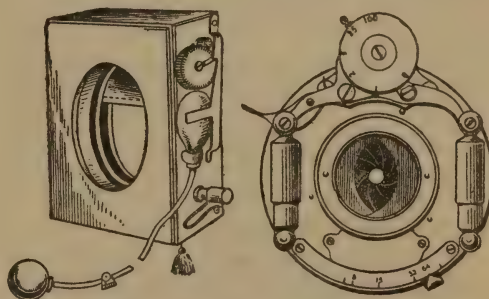
SHOP FRONTS, PHOTOGRAPHING

Shop fronts are always difficult subjects to photograph, because of the many reflections. A method often recommended is to have a black cloth larger than the window, and to place the lens through a hole in the cloth, the latter being fixed or held in such a way as to stop all reflections from the opposite side. This method, however, is rarely possible, because of the large size of some windows and the difficulty of arranging the cloth. The only practical and satisfactory method is to choose a time of day when the sun is not shining on the opposite buildings.

SHORTENING THE FOCUS (See "Focus Adjuster" and "Supplementary Lenses.")

SHUTTERS (Fr., *Obturateurs*; Ger., *Ver-schlüsse*)

Mechanical devices for exposing the plate. Their use is necessitated by the fact that exposures shorter than one-quarter of a second cannot be given by hand, nor even that without risk of



A. Roller-blind Shutter

B. Diaphragm Shutter

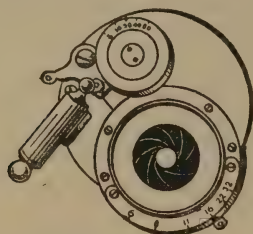
shaking the camera. There are many kinds of shutters, a convenient classification being that which groups them into those working before the lens, between the lens combinations, and behind the lens, though this division is not rigid since many before-the-lens shutters can be used equally well behind. The earlier shutters, such as the flap, drop, and combined drop and flap shutters, belonged to the first class, and are practically obsolete, excepting the first-named, which is still found useful in studio work. The drop shutter has been completely superseded by the roller-blind shutter A, in which a spring blind with a central aperture is caused to pass before the lens. The speed is varied by altering the tension of the spring by means of a winding knob, a given number of turns corresponding to a given speed.

The focal plane shutter (*which see*) is also a roller-blind shutter, but is placed close to the plate. In this, not only can the spring tension be altered, but provision is made for varying the width of the slit or opening, thus giving a greater range of speed. This shutter has a higher efficiency, and is capable of greater rapidity than any other type; but is liable in some cases to cause distortion of moving objects, since the plate is exposed a portion at a time.

In the second class of shutters are included

those known as diaphragm shutters, which work between the combinations of the lens usually by the opening and closing of thin metal or vulcanite plates. The speed is varied either by adjusting the tension of a spring, by a pneumatic brake, or by altering the size of the aperture. Such shutters form part of the lens, as at B.

The rotary shutter, C, which may work either



C. Rotary Shutter

between or in front of the lens, consists of a circular disc with an opening towards the side. This is made to revolve by means of a spring, the opening passing across the lens during the revolution.

The behind-lens bellows studio shutter consists of two semi-circular bellows, which open silently from the centre when the pneumatic ball is pressed, closing again as the latter is released. A clip prevents the return of the air when it is desired to keep the shutter open. (See also "Pneumatic Release," and other headings.)

SHUTTERS, EFFICIENCY OF

The proportion between the length of the exposure and the time during which the lens is fully uncovered. Two shutters may give exposures of the same rapidity, but of very different efficiency. Thus, one may take up the greater portion of the time in opening and shutting, while the other is fully open for the best part of the exposure. It thus results that with the first shutter a longer exposure is required to produce the same light effect as the second. The focal plane shutter is the most efficient, since the whole of the light from the lens reaches the plate.

SHUTTERS, INSTANTANEOUS (See "Instantaneous Shutter.")

SHUTTERS, TESTING

There are many different ways of testing shutter speeds. One is to photograph a wheel revolving at a known rate, and having at its margin a white spot or bright metal disc. On developing the negative, the spot or disc will be found to have formed a curve on the plate, and the length of this curve as compared with the circumference of the image of the wheel, divided into the time of revolution, gives the speed of the shutter. This can readily be carried out by setting a bicycle upside down and attaching a small silvered disc or bright button to one of the spokes close to the edge. The wheel is now set revolving until the disc or button reappears regularly at one place at intervals of exactly a second, the exposure being then made in bright sunshine or by burning magnesium

ribbon. Then, if the curve on the resulting negative measures, say, one-tenth the circumference of the image of the wheel, the exposure is obviously one-tenth of a second. For very rapid exposures the wheel may be revolved at a faster rate.

A bright spot or disc on a pendulum has also been used, allowance having to be made for the fact that the rate of swing is not uniform throughout the beat. A pendulum-testing device for use with a suitably graduated scale is on the market. A. Lockett, in 1909, suggested the employment of a bright ball on a conical pendulum, which revolves in a circle at a regular rate. There are numerous other methods, most of which, however, call for special apparatus.

SIDE SWING

An arrangement whereby the camera back may be inclined in a sideways direction. This adjustment is useful when photographing buildings or other objects that recede from the camera. In such a case, one side of the picture will be out of focus as compared with the other, unless the lens is stopped down; but by using the side swing the definition is equalised, although a slight distortion is introduced.

SIDEBOTHAM'S PROCESS

A waxed paper process introduced by J. Sidebotham, of Manchester, in 1855.

SIDEREAL PHOTOGRAPHY

The photography of stars, the term "sidereal" being derived from a Latin word meaning a star. The methods of photographing stars, planets, nebulae, etc., are described under the heading "Stars, Photographing."

SIDEROSTAT

An instrument used in astronomical photography, photomicrography, spectrography, etc., and known also as a heliostat (*which see*).

SILHOUETTES (Fr., *Silhouettes*; Ger., *Schattenbilder*)

Black profile portraits (as A) showing outline only and no details, so-called from the Frenchman Etienne de Silhouette. They may be produced photographically, as shown in B. A white sheet B is hung in an open doorway; the room

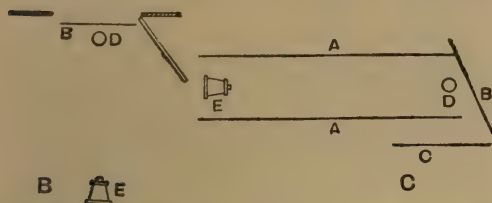


A. Silhouette

being darkened, the sitter D is posed in profile in the room and against the sheet, the camera E being in the room as shown. A short exposure is given, and a strong developer used in order to procure a negative showing the black (clear glass in the negative) profile against a perfectly white (black in the negative) back-

ground. A longer exposure will produce faint details, but these are not required in a true silhouette. At night, flashlight may be used behind the sheet and the same effect produced. The curve at the bottom of the silhouette picture is obtained by painting over the bare glass on the negative with opaque pigment or by covering it with red or black paper. Full-length figures may also be taken.

Another and a widely used method of taking silhouettes is shown in sketch C. Two dark screens A are placed parallel to one another, and a white background B is placed so as to catch the light from the window C. The sitter D is then placed between the screens so as not to



B. and C. Methods of Producing Photographic Silhouettes

catch the direct light from the window; the camera is placed at E, and a dark cloth or curtain is thrown over the screens so as to form a tunnel. The sitter is in the shade, while a brilliant light falls upon the background. Focusing must be accurate in order that the outlines of the figure may be perfectly sharp. Any printing process may be used, but one giving a black-and-white effect is best.

SILK, PHOTOGRAPHS ON (See "Fabrics, Printing on.")

SILVER (Fr., *Argent*; Ger., *Silber*)

Ag. Atomic weight, 108. A white, comparatively soft metal, obtained from numerous ores. It is not attacked by weak acids, but dissolves in cold nitric acid and hot sulphuric acid. It forms a large number of salts, all of which are more or less sensitive to light, and are the bases of most printing processes and the sensitive materials for negative work. Silver exists in various states of fine powder, and can then be either black or coloured.

SILVER ACETATE (Fr., *Acétate d'argent*; Ger., *Silberacetat*)

$\text{AgC}_2\text{H}_3\text{O}_2$. Molecular weight, 167. Solubilities, 1 in 100 water, insoluble in alcohol. It is in the form of fine white powder or crystals, obtained by adding an alkaline acetate to silver nitrate solution or by dissolving silver carbonate in glacial acetic acid. It has been occasionally used in printing-out papers, but it gives yellowish grey images of low intensity, and its sensitiveness is only about one-fifteenth that of silver chloride.

SILVER ACETO-NITRATE

A solution of silver nitrate containing glacial acetic acid, used in the old wet plate days.

SILVER ALBUMINATE (Fr., *Albuminate d'argent*; Ger., *Silberalbuminat*)

A very ill-defined compound of silver nitrate and albumen, which was supposed to form one of the sensitive compounds in the old sensitised albumen paper.

SILVER AMMONIO-NITRATE (Fr., *Ammonio-nitrate d'argent*; Ger., *Salpetersaures Silberoxydammoniak*, or *Silberoxydammoniak*)

Synonym, ammonio-oxide of silver. $\text{AgNO}_3 \cdot 2\text{NH}_3$. Molecular weight, 204. Solubilities, very soluble in water and alcohol. It takes the form of colourless needles, and is obtained by mixing a solution of ammonia with a silver nitrate solution and carefully evaporating, but nearly always it is prepared in solution by adding ammonia to silver nitrate solution till a clear solution is obtained; at first, on the addition of the ammonia, a blackish brown precipitate of silver oxide is formed, which dissolves in excess of ammonia to form a clear solution. A solution thus prepared is used for sensitising plain paper, and also to form silver bromide in emulsion making. According to the above formula, two molecules of ammonia are required for every molecule of silver nitrate, but it is possible to obtain a clear solution with only half the quantity of ammonia by dividing the silver solution into two equal parts, to the one adding enough ammonia solution to obtain a clear solution, and then adding the other half of the silver nitrate. The solution containing the lesser quantity of ammonia gives emulsions freer from fog, but usually of lower sensitiveness.

SILVER AMMONIO-CARBONATE (Fr., *Ammonio-carbonate d'argent*; Ger., *Kohlensaures Silberoxydammoniak*)

$\text{Ag}_2\text{CO}_3 \cdot 4\text{NH}_3$ (ascribed to it by Eder). Molecular weight, 229. Solubilities, soluble in water and alcohol. It is not found in the solid form, but always in solution, and is prepared by adding a solution of ammonium carbonate to a silver nitrate solution, when a yellow precipitate of silver carbonate is first formed, which dissolves in excess of the ammonium carbonate, carbonic acid being evolved. It is occasionally used in emulsion making, particularly for slow, clean-working emulsions.

SILVER AMMONIO-CITRATE (Fr., *Ammonio-citrate d'argent*; Ger., *Citronensaures Silberoxydammoniak*)

Solubilities, very soluble in water and alcohol. It is prepared by adding citric acid to silver nitrate solution, and then a solution of ammonia; a white, curdy precipitate of silver citrate first forms which is soluble in excess of ammonia. It is used in preparing slow, clean-working negative and positive emulsions, and also for printing-out emulsions.

SILVER BATH (Fr., *Bain d'argent*; Ger., *Silberbad*)

A solution of silver nitrate used for sensitising wet collodion plates and albumenised and plain papers, which is frequently designated "48-grain bath," "60-grain bath," etc., this referring to the number of grains of silver nitrate dissolved

in 1 oz. of water. The following are typical formulæ:—

Silver Bath for Line Work

Silver nitrate . . .	300 grs.	69 g.
Distilled water to . .	10 oz.	1,000 ccs.
Potass. iodide sol. (8 grs. per oz.) . . .	7½ mins.	1.56 "
Sod. carbonate crystals	15 grs.	3.45 g.

Silver Bath for Half Tones

Silver nitrate . . .	350 grs.	80 g.
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Other ingredients as above.

Dissolve the silver in one-fourth of the water, add the iodide solution, and shake till the yellow precipitate is dissolved, then add the carbonate and shake well, and then the rest of the water. Place the bath in a bright light for twenty-four hours, filter, and add enough dilute nitric acid to render acid, using methyl orange as an indicator.

Silver Bath for Albumen Paper

The silver bath for albumen paper is usually made thus:—

Silver nitrate . . .	350 grs.	80 g.
Citric acid . . .	500 "	114 "
Distilled water to . .	10 oz.	1,000 ccs.

SILVER BROMIDE (Fr., *Bromure d'argent*; Ger., *Bromsilber*)

Synonym, bromide of silver. AgBr. Molecular weight, 188. Solubilities, practically insoluble in water, alcohol and ether, soluble in ammonia, potassium cyanide and sodium hyposulphite. It is a yellow amorphous powder, obtained by adding any soluble bromide to silver nitrate solution. For photographic purposes it is always prepared in the presence of some vehicle which holds it in suspension in the form of an emulsion and prevents it from forming coarse granules. If, as is usually the case, the bromide is precipitated in the presence of ammonia, a much more sensitive salt is obtained, and the sensitiveness can be increased by digestion in the warmth for some time or merely by allowing the emulsion to stand. Under these conditions the grain of the silver bromide probably increases in size, and also the light which it absorbs alters in character. Freshly prepared gelatino-bromide emulsion is transparent and a deep ruby colour; by the action of ammonia or heat it becomes more opaque, and the light transmitted changes to orange, and by further ripening to yellow, green, greenish blue, and blue, these changes being accompanied by increases in sensitiveness.

Silver bromide is the most light-sensitive silver salt, but, unlike silver chloride, does not give rise to dark-coloured products on prolonged exposure, except in the presence of some halogen absorber such as silver nitrate, potassium nitrite, or metabisulphite. Its spectrum sensitiveness varies with its method of preparation and degree of ripening, but practically it may be considered to extend from the ultra-violet to about F in the bright blue, with the maximum about F½ G.

SILVER CARBONATE (Fr., *Carbonate d'argent*; Ger., *Kohlensaures Silberoxyd*)

Ag₂CO₃. Molecular weight, 276. Solubilities, insoluble in water and alcohol, soluble in potassium cyanide, ammonia, and sodium hypo-

sulphite. It is a yellow granular powder, prepared by adding an alkaline carbonate to silver nitrate solution. Occasionally it is used in printing-out and negative emulsions.

SILVER CHLORATE (Fr., *Chlorate d'argent*; Ger., *Silberchlorat*)

AgClO₃. Molecular weight, 191.5. Solubilities, 1 in 20 water, insoluble in alcohol and ether. It is a white granular powder or minute crystals obtained by dissolving silver oxide or carbonate in chloric acid. It cannot be made by adding a chlorate to silver nitrate. Practically of no photographic importance.

SILVER CHLORIDE (Fr., *Chlorure d'argent*; Ger., *Chlorsilber*)

Synonym, chloride of silver. AgCl. Molecular weight, 143.5. Solubilities, practically insoluble in water, alcohol, and ether, soluble in ammonia, potassium cyanide, and sodium hyposulphite. It is a white granular powder, obtained by precipitation from silver nitrate by adding a soluble chloride. It is used principally for printing-out emulsions and positive development processes.

Red silver chloride (one of Carey Lea's "photo-salts") is produced by acting on ordinary silver chloride with a reducing agent.

SILVER CHROMATE (Fr., *Chromate d'argent*; Ger., *Silberchromat*)

Ag₂CrO₄. Molecular weight, 332. Solubilities, insoluble in water, alcohol, and ether; soluble in ammonia and "hypo." It is in the form of a red amorphous powder, obtained by adding potassium chromate to silver nitrate solution. The addition of a very small proportion of this salt to a printing-out emulsion reduces the gradation, and makes the paper more suitable for thin, flat negatives.

SILVER CITRATE (Fr., *Citrate d'argent*; Ger., *Silbercitrat*, *Citronensaures Silberoxyd*)

Synonym, citrate of silver. AgC₆H₅O₇. Molecular weight, 297. Solubilities, insoluble in water, alcohol and ether, soluble in ammonia, potassium cyanide and "hypo." It is a curdy, white powder, obtained by adding an alkaline citrate to silver nitrate solution; practically but little citrate is formed by using citric acid. It is employed in printing-out emulsions.

SILVER CUTTINGS (See "Residues.")

SILVER CYANIDE (Fr., *Cyanure d'argent*; Ger., *Silbercyanid*)

AgCN. Molecular weight, 134. Solubilities, insoluble in water, alcohol, and ether, soluble in ammonia, potassium cyanide, and "hypo." It is a white powder, obtained by adding an alkaline cyanide to silver nitrate solution; it is the blackening agent in Monckhoven's intensifier.

SILVER FLUORIDE (Fr., *Fluorure d'argent*; Ger., *Silberfluorid*)

AgF. Molecular weight, 199. Solubilities, very soluble in water and alcohol. It takes the form of yellow conglomerate crystals, obtained by dissolving silver oxide or carbonate in hydrofluoric acid; it cannot be made by adding an alkaline fluoride to silver nitrate.

SILVER IMAGE (Fr., *Image d'argent*; Ger., *Silberbild*)

A term applied to negatives or positives produced by the action of light on a silver salt.

SILVER INTENSIFIER

The silver intensifier has the advantage that the density is under control, and either little or much intensification can be given. The film should be hardened in a 10 per cent. solution of formaline for three minutes and then washed in water. Wellington's formula (1889) is:—

A. Silver nitrate	. 120 grs.	28 g.
Water (distilled)	. 2 oz.	200 ccs.
B. Ammonium sulphocyanide	. 240 grs.	56 g.
Water	. 3 oz.	300 ccs.

Add B to A, and keep in a dark place. The bottle is shaken immediately before use, and some of the liquid poured into a vessel. A strong "hypo" solution is then added very slowly till all but a trace of the precipitate has dissolved. To each ounce of this solution 3 grs. of a 10 per cent. stock solution of pyro (preserved with sodium sulphite) and 4 mins. of liquor ammoniæ are added, and the solution poured upon the plate and allowed to act until the desired density is obtained. A few drops more of ammonia may be added if the action is slow in beginning, but too much will spoil the bath by precipitating the silver. The plate is then refixed for ten minutes in an ordinary "hypo" bath and then well washed. As the intensifier contains "hypo," a prolonged washing is not necessary after the first fixing and previous to intensifying. Many modifications of the above formula have appeared, but all are much alike in the results they give. Some workers recommend the rinsing of the intensified plate in a bath of 6 mins. of hydrochloric acid and 1 oz. of water before re-fixing, using an alkaline fixing bath.

For Farmer's silver intensifier, solutions of 1 oz. of silver nitrate in 12 oz. of distilled water and $\frac{3}{4}$ oz. of potassium bromide in 2 oz. of distilled water are mixed together, and the precipitate is removed, washed with water, and stirred into a solution of 2 oz. of "hypo" in 6 oz. of water. In a few hours' time, filter and make up to 16 oz. with distilled water. In this immerse the negative for five minutes, and then develop with ferrous oxalate or with a pyro-silver bath, consisting of pyro, 4 grs.; distilled water, 2 oz.; silver solution, 60 mins.; and 10 per cent. solution of '880 ammonia, 30 mins.

Wellington's improved formula (1911) is given under the heading "Wellington's Silver Intensifier." For Monckhoven's intensifier, see under its own heading.

SILVER IODIDE (Fr., *Iodure d'argent*; Ger., *Iodsilber*)

AgI . Molecular weight, 235. Solubilities, practically insoluble in water, alcohol, and ether, soluble in potassium cyanide, and "hypo." It is obtained by adding a soluble iodide to silver nitrate solution; when precipitated in the presence of excess of alkaline iodide it is a pale yellow powder, whilst with excess of silver nitrate it is a deep orange, curdy precipitate; the latter darkens in light, whilst the former undergoes no

visible change. It is but very slightly soluble in strong ammonia, 1 in 2,500 parts, but it is readily soluble in potassium iodide solution, forming a double salt AgIKI , or AgI_2KI , both of which are decomposed by the addition of water, depositing pale yellow powdery silver iodide. It is also soluble in silver nitrate solution, forming the double salt $2\text{AgNO}_3\text{AgI}$, which is more soluble in cold than in hot solutions. A 10 per cent. solution of the nitrate dissolves .053 per cent. AgI , an 8 per cent. solution .077 per cent., and alcoholic and ethereal solutions dissolve more. The negative silver bath for sensitising wet collodion plates should always be saturated with silver iodide before use, otherwise the iodide will be dissolved from the film.

Silver iodide is chiefly employed for the wet-plate process, and as an addition to gelatinobromide emulsions, in which it acts as a restrainer of fog during digestion and produces greater sensitiveness. It is usually mixed with the alkaline bromide, and it is supposed to form a double salt generally known as bromo-iodide of silver, and this is confirmed by the fact that such an emulsion only shows one maximum of sensitiveness in the spectrum, whereas the two salts separately emulsified and then mixed show two distinct maxima.

SILVER LACTATE (Fr., *Lactate d'argent*; Ger., *Silberlactat*, *Milchsaures Silber*)

$\text{AgC}_2\text{H}_3\text{O}_2 \cdot \text{H}_2\text{O}$. Molecular weight, 215. It is in the form of white crystals or powder, obtained by dissolving silver carbonate in lactic acid. It is very rarely used, and then in printing-out emulsions.

SILVER METER (See "Argentometer.")**SILVER NITRATE** (Fr., *Azotate d'argent*; Ger., *Silbernitrat*, *Salpetersaures Silber*)

AgNO_3 . Molecular weight, 170. Solubilities, 1 in 1 water, 1 in 26 alcohol, 1 in 5 boiling alcohol. It is in the form of colourless rhombic plates, and is obtained by direct solution of silver in nitric acid or by dissolving the oxide or carbonate. It is not in itself sensitive to light, but is readily reduced to the metallic state in the presence of organic matter, such as gelatine, paper, or the skin. It is the salt from which are formed all sensitive materials in photography in which silver is used.

In process work, silver nitrate is sometimes used for etching baths for steel, and the following formula is recommended:—Alcohol 6 parts, distilled water 6 parts, pure nitric acid 16.6 parts, silver nitrate .83 part.

SILVER NITRITE (Fr., *Azotite d'argent*; Ger., *Salpêtrigsaures Silber*)

AgNO_2 . Molecular weight, 154. Solubilities, 1 in 300 water. It is a crystalline white powder, obtained by precipitation from silver nitrate by an alkaline nitrite, and is of no photographic importance.

SILVER OXALATE (Fr., *Oxalate d'argent*; Ger., *Silberoxalat*, *Oxalsäures Silber*)

$\text{Ag}_2\text{C}_2\text{O}_4$. Molecular weight, 304. Solubilities, practically insoluble in water and alcohol,

soluble in nitric acid. It is a white crystalline powder, obtained by adding an alkaline oxalate to silver nitrate. It has been suggested for printing-out emulsions, but is rarely used.

SILVER OXIDE (Fr., *Oxyde d'argent*; Ger., *Silberoxyd*)

Ag_2O . Molecular weight, 232. Solubilities, practically insoluble in water, alcohol, and ether. It is a heavy, brownish-black powder, obtained by precipitation from silver nitrate by a caustic alkali, and is practically of no importance photographically.

SILVER PHOSPHATE (Fr., *Phosphate d'argent*; Ger., *Silberphosphat*)

Synonym, normal silver orthophosphate. Ag_3PO_4 . Molecular weight, 419. Solubilities, insoluble in water, alcohol, and ether, soluble in organic acids, ammonia, potassium cyanide, and "hypo." It is used for printing-out emulsions, and gives an extremely long scale of gradation—that is, very soft flat prints from strong negatives. It occurs as a heavy yellow powder and can be prepared by adding phosphoric acid to silver nitrate or by using ordinary sodium phosphate (Na_2HPO_4); the reaction that takes place is $3\text{AgNO}_3 + \text{Na}_2\text{HPO}_4 = \text{Ag}_3\text{PO}_4 + 2\text{NaNO}_3 + \text{HNO}_3$. The resulting liquid contains free nitric acid, which dissolves some of the silver phosphate.

SILVER POISONING

All silver salts are more or less poisonous when taken internally, and the antidotes are table-salt or any soluble chloride followed by emetics and mucilaginous drinks, or white of egg and milk, and the use of the stomach pump.

SILVER PRINTS

A generic term, including all prints of which the image is metallic silver, such as plain or salted paper, collodio-chloride, gelatino-chloride, bromide and gaslight and kallitype prints.

SILVER PROCESSES

All processes or methods in which silver is used.

SILVER RESIDUES (See "Residues.")

SILVER SALTS

A description of the individual silver salts is given under their respective headings. Practically all the silver salts are sensitive to light either *per se* or in contact with organic matter. Marktanner Turneretscher compiled the following table, which gives an extremely useful outline of the sensitiveness of the various salts and the intensity of the printed-out image. He used a Vogel photometer, exposed the paper for an equal time, took the last visible number as the speed, silver chloride on paper being set as 100.

SILVER SALTS: TURNERETSCHER'S TABLE OF SENSITIVENESSES, ETC.

Name and chemical formula (solubility)	I.—WITH EXCESS OF SILVER				II.—WITH EXCESS OF SALT				Remarks
	A.—Without ammonia fuming		B.—With ammonia fuming		A.—Without ammonia fuming		B.—With ammonia fuming		
	Sensitiveness for $\text{AgCl}=100$	Colour and intensity of the same	Sensitiveness for $\text{AgCl}=100$	Colour and intensity of the same	Sensitiveness for $\text{AgCl}=100$	Colour and intensity of the same	Sensitiveness for $\text{AgCl}=100$	Colour and intensity of the same	
1. Silver chloride, AgCl (insoluble)	100	Blue black; very intense	100	Blue black; more intense than without fuming	80	Violet; very intense	200	Violet; very intense	Although very intense with excess of salt, yet less than with excess of silver
2. Silver bromide, AgBr (insoluble)	700	Bluish grey; not intense	900	Bluish grey; not intense	250	Bluish grey; not intense	300	Bluish grey; not intense	Scarcely more intense with than without ammonia fuming
3. Silver iodide, AgI (insoluble)	300	Greenish grey; not intense	450	Reddish grey; not intense	40	Yellowish grey; not intense	75	Yellowish grey; not intense	Fuming scarcely increases the intensity
4. Silver chloride freed from excess of silver by washing before exposure	95	Slightly reddish violet; very intense	100	Slightly reddish violet; very intense					Less intense than normal paper; scarcely more intense with fuming
5. Silver chloride, washed as in 4, then floated on a solution of potass. nitrite	80	Near the normal paper in intensity	130	Equal to the normal paper					Prepared according to Abney's process
6. Silver chloride, washed as in 4, then floated on sodium sulphite solution	100	Violet; very intense	100	Violet; very intense					Does not quite equal the intensity of the normal paper, but much more intense than washed paper.

SILVER SALTS: TURNERETSCHER'S TABLE OF SENSITIVENESSES, ETC.

—continued

Name and chemical formula (solubility)	I.—WITH EXCESS OF SILVER				II.—WITH EXCESS OF SALT				Remarks
	A.—Without ammonia fuming		B.—With ammonia fuming		A.—Without ammonia fuming		B.—With ammonia fuming		
	Sensitiveness for AgCl=100	Colour and intensity of the same	Sensitiveness for AgCl=100	Colour and intensity of the same	Sensitiveness for AgCl=100	Colour and intensity of the same	Sensitiveness for AgCl=100	Colour and intensity of the same	
7. Silver nitrate, AgNO ₃ (on paper)	6	Reddish; not intense	8	Reddish; not intense					Silver nitrate does not darken alone, only in the presence of organic matter
8. Silver albuminate without silver nitrate	13	Red; slightly intense	30	Bluish; slightly intense					Prepared by floating paper on whipped albumen, then on AgNO ₃
9. Silver chloride albumen paper, freshly sensitised	50	Purple brown; very intense	60	Purple brown; very intense					So-called "Rosabrilant" paper was used
10. Preserved commercial silver chloride albumen paper	70	Purple brown; very intense	80	Purple brown; very intense					
11. Gelatino-bromide dry plate					600	Greenish grey; not intense			
12. Silver formate, H—COOAg									The sensitised paper darkened even in an absolutely dark room
13. Silver acetate, CH ₃ —COOAg (1:97)	6	Yellowish grey; slightly intense	20	Reddish grey; tolerably intense	4	Yellowish grey; not intense	15	Reddish grey; slightly intense	
14. Silver propionate, CH ₃ —CH ₂ —COOAg (1:119)	6	Red brown; slightly intense	10	Yellow brown; slightly intense	7	Red brown; slightly intense	15	Yellow brown; slightly intense	
15. Normal silver butyrate, CH ₃ (CH ₂) ₂ COOAg (1:200)	8	Reddish yellow; moderately intense	22	Red brown; moderately intense	10	Reddish grey; moderately intense	20	Grey brown; moderately intense	Colour more intense than with the isobutyrate
16. Silver isobutyrate, (CH ₃) ₂ —CH—COOAg (1:108)	7	Yellowish red; not intense	18	Brownish; slightly intense	6	Reddish brown; slightly intense	18	Red brown; slightly intense	Colour somewhat less intense than with the normal salt
17. Silver valerianate, (CH ₃) ₂ CHCH ₂ —COOAg (1:540)	8	Violet brown; moderately intense	14	Reddish grey; tolerably intense	14	Reddish grey; moderately intense	30	Grey brown; moderately intense	
18. Silver caproate, (CH ₃) ₂ CH(CH ₂) ₂ —COOAg (soluble with great difficulty)	9	Grey; moderately intense	15	Grey; moderately intense	14	Reddish brown; tolerably intense	24	Grey; moderately intense	
19. Silver heptylate, CH ₃ (CH ₂) ₄ COOAg (soluble with difficulty)	10	Brownish violet; tolerably intense	14	Grey violet; tolerably intense	14	Brown violet; tolerably intense	16	Grey brown; intense	
20. Silver octylate, CH ₃ (CH ₂) ₅ COOAg (scarcely soluble)	12	Grey; slightly intense	5	Grey; not intense	17	Reddish brown; tolerably intense	6	Grey brown; slightly intense	
21. Silver pelargonate, CH ₃ (CH ₂) ₇ COOAg (insoluble in cold water)	25	First red, then grey; tolerably intense	30	Grey; tolerably intense	20	First red, then grey; tolerably intense	25	Brown; tolerably intense	

SILVER SALTS: TURNERETSCHER'S TABLE OF SENSITIVENESSES, ETC.

—continued

Name and chemical formula (solubility)	I.—WITH EXCESS OF SILVER				II.—WITH EXCESS OF SALT				Remarks
	A.—Without ammonia fuming		B.—With ammonia fuming		A.—Without ammonia fuming		B.—With ammonia fuming		
	Sensitiveness for AgCl=100	Colour and intensity of the same	Sensitiveness for AgCl=100	Colour and intensity of the same	Sensitiveness for AgCl=100	Colour and intensity of the same	Sensitiveness for AgCl=100	Colour and intensity of the same	
22. Silver caproate, $\text{CH}_3(\text{CH}_2)_6\text{COOAg}$ (insoluble)	5	Brown violet; slightly intense	6	Reddish grey; not intense	14	Reddish brown; tolerably intense	18	Reddish grey; tolerably intense	The paper remained white for several weeks when kept in the dark
23. Silver palmitate, $\text{CH}_3(\text{CH}_2)_{14}\text{COOAg}$ (insoluble)	5	Yellowish; not intense	6	Yellowish grey; not intense	3	Yellowish; not intense	8	Yellowish grey; not intense	The salt solution was used $\frac{1}{5}$ normal
24. Silver stearate, $\text{CH}_3(\text{CH}_2)_{16}\text{COOAg}$ (insoluble)	14	Grey; not intense	22	Grey; not intense					In one whole day's exposure the paper turns velvet brown; solution of the salt $\frac{1}{2}$ normal
25. Silver cerotate, $\text{CH}_3(\text{CH}_2)_{25}\text{COOAg}$ (insoluble)	1	Yellowish grey; slightly intense	5	Yellowish; slightly intense	2	Yellowish; not intense	5	Yellowish; not intense	The salt solution was used $\frac{1}{10}$ normal
26. Silver oleate, $\text{C}_{18}\text{H}_{33}\text{COOAg}$	10	Reddish grey; slightly intense	11	Greenish grey; slightly intense	9	Reddish grey; slightly intense	6	Grey; slightly intense	The salt solution was used $\frac{1}{2}$ normal
27. Silver glycolate, $\text{CH}_2\text{OH.COOAg}$ (soluble with difficulty)	6	Yellow red; tolerably intense	11	Brownish; slightly intense	4	Yellowish grey; not intense	7	Brownish; not intense	
28. Silver lactate, $\text{CH}_3\text{CHOHCOOAg}$ (1 : 20)	8	Yellowish red; tolerably intense	16	Yellow red; tolerably intense	17	Rusty yellow; tolerably intense	18	Grey; tolerably intense	On account of the insolubility of the salt alcohol was used to prepare the paper
29. Silver paralactate, $\text{CH}_3\text{CHOHCOOAg}$	7	Yellowish red; tolerably intense	17	Yellow red; tolerably intense	17	Rusty yellow to brown; tolerably intense	17	Grey brown; tolerably intense	The paper prepared with excess of salt was rather more intense than with excess of silver
30. Silver oxalate, $\text{COOAg}—\text{COOAg}$ (insoluble)	2	Reddish; not intense	80	Red brown; very intense	20	Dark brown; intense	70	Dark brown; very intense	
31. Silver malonate, $\text{CH}_2\text{OH}(\text{COOAg})_2$ (soluble with difficulty)	4	Reddish grey; slightly intense	8	Grey; tolerably intense	5	Reddish yellow; slightly intense	13	Reddish brown; tolerably intense	
32. Silver malate, $\text{C}_2\text{H}_3\text{OH}(\text{COOAg})_2$ (soluble in hot water)	2	Red brown; slightly intense	18	Grey brown; intense	7	Red brown; intense	13	Red brown; very intense	
33. Silver tartrate, $(\text{CHOH})_2(\text{COOAg})_2$ (soluble with difficulty)	7	Red brown; intense	17	Red brown; intense	6	Reddish brown; tolerably intense	24	Red brown; very intense	
34. Silver citrate, $\text{C}_6\text{H}_5\text{O}_7\text{Ag}$ (soluble in boiling water)	15	Grey brown; moderately intense	18	Red brown; intense	6	Brown; moderately intense	12	Grey brown; intense	
35. Silver hippurate, $\text{NHC}_7\text{H}_5\text{O}_6$ $\text{CH}_2 < \text{COOAg}$	12	Rusty brown; tolerably intense	24	Grey brown; tolerably intense	16	Rusty brown; tolerably intense	50	Grey brown; tolerably intense	

SILVER STAINS

Dark brown or red stains which appear on negatives during or after printing upon P.O.P. or other paper containing soluble silver salts, either the paper or the negative being damp. To prevent them the negative should be varnished. To remove them, immerse the negative in a solution of 20 grs. of potassium iodide in 1 oz. of water for ten minutes, rinse thoroughly, and transfer to a solution of 30 grs. of potassium cyanide. Dab the stains with a tuft of cotton-wool soaked in the solution until they disappear, when the negative should be rinsed thoroughly and dried. (See also "Stains, Removing.")

SILVER SUBBROMIDE, SUBCHLORIDE, ETC. (See "Silver Subhaloids.")**SILVER SUBHALOIDS**

Chemists have usually considered that the action of light upon the silver haloids was the splitting off of a molecule of the halogen and the formation of a salt with consequent lower proportion of halogen, which may be represented by the formula, $2\text{AgCl} = \text{Ag}_2\text{Cl} + \text{Cl}$ or $4\text{AgCl} = \text{Ag}_4\text{Cl}_2 + \text{Cl}_2$. They named the new compounds subhaloids. For many years the existence of such subsalts was denied, because the actual existence of silver suboxide could not be definitely proved. In 1891 Guntz was able to prepare the subfluoride Ag_3F or Ag_4F_2 by heating silver fluoride AgF in a sealed tube at a temperature not above 194°F . with finely divided silver and also by electrolysis of a saturated solution of silver fluoride, using silver electrodes. By treatment of this salt, a yellow crystalline powder, with steam he was able to prepare the suboxide Ag_4O , and Weltzien prepared a silver hydroxide $\text{Ag}_4(\text{OH})_2$ by treating it with hydrogen peroxide. From the subfluoride Guntz also prepared the subchloride by passing dry hydrochloric acid gas over it, or by treating it with the volatile chlorides of carbon, silicon, and phosphorus, etc. The subchloride varies in colour from deep violet red to violet black, and when heated it splits up into ordinary silver chloride and metallic silver potassium cyanide; and sodium hyposulphite produces a similar reaction with the solution of the chloride. Silver subiodide was also prepared by Guntz by the action of hydrogen iodide. The actual formation of these subhaloids is a strong argument in favour of the subhaloid theory of the latent image (*which see*). The subbromide may be prepared in the same way as the subchloride, or by treating the subfluoride with phosphorus tribromide (Heyer). Lüppo-Cramer claims to have prepared a subbromide, Ag_4Br_2 , by treating mercurous bromide with silver nitrate.

SILVER SULPHATE (Fr., *Sulfate d'argent*; Ger., *Silbersulfat*, *Schwefelsaures Silberoxyd*)

Ag_2SO_4 . Molecular weight, 312. Solubility, .58 in 100 water. White crystals obtained by mixing concentrated solutions of silver nitrate and sodium sulphate.

SILVER SULPHIDE (Fr., *Sulfure d'argent*; Ger., *Silbersulfid*)

Ag_2S . Molecular weight, 248. Solubilities, insoluble in water and alcohol. It is a brownish-

black powder, and is obtained by mixing an alkaline sulphide with silver nitrate solution. It is also obtained when liver of sulphur is added to spent fixing baths, and is supposed to form the brown or sepia image in sulphide toned bromides.

SILVER SULPHOCYANIDE (Fr., *Sulfocyanure d'argent*; Ger., *Silber-rhodanat*)

AgCNS . Molecular weight, 166. Solubilities, very soluble in water. Yellowish white crystals obtained by adding silver nitrate to an alkaline sulphocyanide. It is of no photographic importance.

SILVER TARTRATE (Fr., *Tartrate d'argent*; Ger., *Silbertartrat*, *Weinsteinsäures Silber*)

$\text{Ag}_2\text{C}_4\text{H}_4\text{O}_6$. Molecular weight, 364. Solubilities, slightly soluble in water. It is a fine, white powder, obtained by adding silver nitrate to an alkaline tartrate. It is used in printing-out emulsions.

SILVER TESTER (See "Argentometer.")**SILVER WASHINGS** (See "Residues.")**SILVERLINE PROCESS**

A French process of line engraving. A zinc plate was coated with an etching ground, a drawing scratched through with a needle point, and the lines etched deeply. The resist was then cleaned off, and the lines filled in with soft solder consisting of a mixture of bismuth, tin, and lead. The solder was melted by heating the plate with buttons of solder on it, and rubbing the molten solder in the lines with a rag. The surface was polished and the plate again etched in nitric acid, which attacked the zinc without touching the solder, and thus the lines were left in relief.

SILVERWARE, PHOTOGRAPHING

The task of rendering silver as silver is a difficult one, and the secret of success lies in the lighting and the use of backed plates. The operator should remember that the angle of reflection is always equal to the angle of incidence; thus, at whatever angle the light falls on a reflective surface, it is reflected back at the same angle. It will therefore be obvious that, if the silver object be illuminated by a strong front light, the reflections will come back into the lens. The most suitable angle at which the strongest light should reach the bright objects is one of about 45° ; then the reflections will be well away from the direction of the camera. The shadow sides will be rather dark as compared with the bright high lights, but this will be modified by using a reflector, which may be a sheet of white cardboard.

If the silver objects can be treated to prevent reflections, the task of getting a satisfactory photograph of them becomes easy. Many methods have been advocated for dulling the surfaces. One of the best is to hold the silver over a piece of burning magnesium ribbon, the white smoke from which will deposit upon the silver; the magnesium can easily be removed. A method frequently adopted is to dab the surfaces with putty, but this is rather messy and

troublesome to clean off. A better plan is to place a piece of ice in each vessel; this causes the metal to cool rapidly, and if there is moisture in the atmosphere, as upon a wet or damp day, dew will soon deposit upon it; in exceptionally dry weather the cold metal could be sprayed, using water in an ordinary scent sprayer, or could be steamed.

Any lettering on the articles can be brought out by arranging the light and the reflector, or the lettering may be filled up with black printers' ink, which can be quickly cleaned out with benzole or turpentine after the negative has been made.

Exposures should be full in order to soften the contrasts, as under-exposure would mean brighter and glaring high lights and black shadows. The developer used—say, metol or rodinal—should bring out the details in the shadows before the high lights become too strong.

SIMILIGRAVURE

A French name for the half-tone process.

SIMPSONTYPE

A printing process—the collodio-chloride—discovered by George Wharton Simpson, in which silver chloride contained in collodion was employed (published 1864). The original formula was: A. Silver nitrate $\frac{3}{4}$ oz. and distilled water $\frac{3}{4}$ oz.; warm gently until dissolved, and add 5 oz. of alcohol. B. Calcium chloride, 160 grs.; absolute alcohol, 5 oz. C. Citric acid 160 grs., absolute alcohol 5 oz. Take 40 oz. of plain collodion of medium density and add to it solution A, a little at a time, with considerable shaking. This may be done in daylight, but the following operations must be carried out in the dark-room or by weak artificial light. Next add B and C in the manner described for A. The emulsion is applied to glass, opal or paper. G. W. Simpson was for many years editor of the *Photographic News*; he died in 1880.

SINGLE LENS

The so-called landscape lens; an achromatic meniscus, composed of flint and crown glass.

When cameras are listed with "achromatic" lens, a single lens is usually meant, not a rapid rectilinear.

SINGLE TRANSFER

The method of working the carbon process by transferring the film from the paper on which it is printed to a second paper which forms its final support.

SINKS (See "Developing Bench or Sink.")

SINOP PROCESS

A simplified method of collotype printing, invented by Pousin, of Rheims. Plates are sold ready coated with an emulsion, which is believed to be gelatine containing a mercurous salt. These plates, which keep indefinitely, are sensitised by bathing in a potassium bichromate solution. They are dried and exposed under a negative, then washed to remove the unaltered bichromate, soaked in glycerine, the surplus moisture removed, and the plate inked up with a gelatine roller and greasy ink. Impressions on paper are then pulled off in an ordinary letter-copying press.

SIZEOMETER (See "Proportional Scales and Rules.")

SIZES OF PLATES AND PAPERS

The accompanying tables give the sizes and diagonals of British and Continental plates and of films, and sizes of drawing papers and of mounts. It should be remembered that Continental dark-slides are to the sizes given, the plates being made from 1 to $1\frac{1}{2}$ mm. smaller so as to fit. In Great Britain plates are made to the sizes stated, and there is an allowance in the dark-slide.

The diagonals of plates are often referred to when condensers for enlarging are being considered, as a suitable condenser should have a diameter equal to the diagonal of the plate. Thus, a half-plate negative needs a condenser at least 8 in. in diameter, in order to cover the corners of the negative.

BRITISH PLATES				CONTINENTAL PLATES				FILMS			
Dimensions		Diagonals		Dimensions		Diagonals		Dimensions		Diagonals	
In.	Cm.	In.	Cm.	In.	Cm.	In.	Cm.	In.	Cm.	In.	Cm.
$3\frac{1}{2} \times 2\frac{1}{2}$	8.9 × 6.3	$4\frac{1}{2}$	10.9	1.5 × 1.5	4 × 4	2.25	5.7	2 × $1\frac{1}{2}$	5 × 3.8	2 $\frac{1}{2}$	6.3
$3\frac{1}{2} \times 3\frac{1}{2}$	8.3 × 8.3	$4\frac{1}{2}$	11.7	1.77 × 2.36	$4\frac{1}{2} \times 6$	2.9	7.5	2 $\frac{1}{2} \times 1\frac{1}{2}$	5.7 × 3.8	2 $\frac{1}{2}$	6.9
(Lantern plate)				2.56 × 3.5	$6\frac{1}{2} \times 8.9$	4.6	11.1	2 $\frac{1}{2} \times 2\frac{1}{2}$	5.7 × 5.7	3 $\frac{1}{2}$	8.1
$4\frac{1}{2} \times 3\frac{1}{2}$	10.8 × 8.3	5 $\frac{1}{2}$	10.6	3.54 × 4.7	9 × 12	5.9	14.9	2 $\frac{1}{2} \times 1\frac{1}{2}$	6.3 × 4.2	3	6.9
(Quarter-plate)				3.54 × 7.08	9 × 18	7.9	20.0	2 $\frac{1}{2} \times 3\frac{1}{2}$	5.7 × 8.3	3 $\frac{1}{2}$	10.0
5 × 4	12.8 × 10.1	6 $\frac{1}{2}$	16.2	4.3 × 5.90	11 × 15	7.3	18.6	4 $\frac{1}{2} \times 2\frac{1}{2}$	10.8 × 6.3	4 $\frac{1}{2}$	22.5
$5\frac{1}{2} \times 3\frac{1}{2}$	14.0 × 8.9	6 $\frac{1}{2}$	16.6	4.7 × 6.29	12 × 16	7.9	20.1	4 $\frac{1}{2} \times 3\frac{1}{2}$	8.9 × 8.9	5	12.6
(Post card)				4.7 × 7.87	12 × 20	9.2	23.3	4 $\frac{1}{2} \times 3\frac{1}{2}$	10.8 × 8.3	5 $\frac{1}{2}$	10.6
$6\frac{1}{2} \times 4\frac{1}{2}$	16.5 × 10.7	7 $\frac{1}{2}$	19.6	5.1 × 7.08	13 × 18	8.7	22.1	5 $\frac{1}{2} \times 3\frac{1}{2}$	14.0 × 8.3	6 $\frac{1}{2}$	16.2
(Double quarter)				5.9 × 8.26	15 × 21	10.2	26	5 × 4	12.8 × 10.1	6 $\frac{1}{2}$	16.2
$6\frac{1}{2} \times 4\frac{1}{2}$	16.5 × 12.0	8 $\frac{1}{8}$	20.4	7.08 × 9.45	18 × 24	11.9	30.1	6 $\frac{1}{2} \times 4\frac{1}{2}$	16.5 × 10.7	7 $\frac{1}{2}$	19.6
(Half-plate)				8.26 × 10.63	21 × 27	13.5	34.2	7 × 5	17.8 × 12.7	8 $\frac{1}{2}$	21.9
$6\frac{1}{2} \times 3\frac{1}{2}$	17.2 × 8.2	7 $\frac{1}{2}$	19.0	9.45 × 11.8	24 × 30	15.3	39	3 $\frac{1}{2} \times 2\frac{1}{2}$	8.3 × 5.7	3 $\frac{1}{2}$	10
(Stereoscopic)								3 $\frac{1}{2} \times 4\frac{1}{2}$	8.9 × 1.77	5 $\frac{1}{2}$	14.6
7 × 5	17.8 × 12.7	8 $\frac{1}{2}$	21.9					9 × 3 $\frac{1}{2}$	22.8 × 8.9	9 $\frac{1}{2}$	24.5
$8\frac{1}{2} \times 6\frac{1}{2}$	21.6 × 16.5	10 $\frac{1}{2}$	27.1								
(Whole-plate)											
10 × 8	25.3 × 20.3	12 $\frac{1}{2}$	32.7								
and larger											

and six larger sizes, 24 × 36 cm., 27 × 33 cm., 30 × 40 cm., 36 × 48 cm., 40 × 50 cm., and 50 × 60 cm.

Sensitised Papers

Sensitive papers may be had cut up to almost any size, from about $2\frac{1}{2}$ by $1\frac{1}{2}$ in. to 21 by 25 in., rectangular, square, or circular. The full sizes of complete sheets vary somewhat, but the following may be taken as the average:—

Bromide and gaslight paper.—Rolls, 10 and 25 ft. long; 15, 20, 22, 25, 30, and 40 in. wide.

P.O.P.—Sheets, $24\frac{1}{2}$ by 17 in. Rolls, 25 ft. long and 12 and 25 in. wide.

Platinotype.—Sheets, 26 by 20 in.

Carbon.—In "bands" 12 ft. long, 30 in. wide.

Ferro-prussiate.—Rolls, 32 ft. long, 30 and 40 in. wide.

Drawing Papers

Demy	22	×	17	in.
Royal	25	×	20	"
Cartridge	26	×	21	"
Double crown	30	×	22	"
Imperial	30	×	22	"
Double demy	35	×	27	"
Double elephant	40	×	22	"
Antiquarian	53	×	31	"

	In.	Cm.
BRITISH MOUNTS—		
Midget	$1\frac{1}{8}$ × $2\frac{1}{4}$	$3\frac{3}{8}$ × $5\frac{7}{8}$
C. de V.	$2\frac{1}{8}$ × $4\frac{1}{4}$	$6\frac{3}{8}$ × $10\frac{5}{8}$
Cabinet	$6\frac{1}{8}$ × $4\frac{1}{4}$	$16\frac{5}{8}$ × $10\frac{5}{8}$
Imperial	$6\frac{1}{8}$ × 10	$17\frac{5}{8}$ × $25\frac{1}{4}$
Promenade	$7\frac{1}{8}$ × $9\frac{7}{8}$	20 × $25\frac{1}{8}$
Boudoir	$8\frac{1}{8}$ × 4	$21\frac{1}{8}$ × $10\frac{1}{8}$
Panel	$8\frac{1}{8}$ × $5\frac{1}{8}$	$21\frac{1}{8}$ × 14
Stereoscopic	13 × $7\frac{1}{2}$	$33\frac{3}{8}$ × 19
Royal	$8\frac{1}{8}$ × 4	$21\frac{1}{8}$ × $10\frac{1}{8}$
Large Panel	7 × $3\frac{1}{2}$	$17\frac{7}{8}$ × 8-9
Grand Panel	$10\frac{1}{8}$ × $5\frac{1}{8}$	27 × 13
Victoria Midget	$10\frac{1}{8}$ × 17	$26\frac{7}{8}$ × $43\frac{1}{8}$
Cabinet Midget	23 × $13\frac{1}{8}$	$58\frac{1}{4}$ × $34\frac{1}{8}$
Promenade Midget	$2\frac{1}{8}$ × $1\frac{1}{8}$	6 × $3\frac{1}{8}$
Boudoir Midget	$2\frac{1}{8}$ × $1\frac{1}{8}$	$6\frac{1}{8}$ × $4\frac{1}{4}$
Panel Midget	$3\frac{1}{8}$ × $1\frac{1}{8}$	$7\frac{1}{8}$ × $4\frac{1}{8}$
CONTINENTAL MOUNTS—		
Carte Mignonnette	$1\frac{1}{8}$ × $2\frac{1}{8}$	$3\frac{1}{8}$ × 6
Carte de Visite	$2\frac{1}{8}$ × $4\frac{1}{8}$	$6\frac{3}{8}$ × $10\frac{5}{8}$
Carte Malvern	$3\frac{1}{8}$ × $6\frac{1}{8}$	8 × $16\frac{1}{8}$
Carte Victoria	$3\frac{1}{8}$ × 5	8 × $12\frac{1}{8}$
Carte Album	$4\frac{1}{8}$ × $6\frac{1}{8}$	11 × $16\frac{1}{8}$
Carte Cabinet	$4\frac{1}{8}$ × $6\frac{1}{8}$	12 × 16
Carte Promenade	$3\frac{1}{8}$ × $4\frac{1}{8}$	10 × 12
Carte Paris Portrait	$5\frac{1}{8}$ × $8\frac{1}{8}$	$13\frac{3}{8}$ × 22
Carte Amateur	$3\frac{1}{8}$ × $4\frac{1}{8}$	9 × 12
Carte Artiste	$5\frac{1}{8}$ × $7\frac{1}{8}$	13 × 18
Carte American	$5\frac{1}{8}$ × $8\frac{1}{8}$	15 × 21
Carte Family	$7\frac{1}{8}$ × $9\frac{1}{8}$	18 × 24
Carte Excelsior	$7\frac{1}{8}$ × $10\frac{1}{8}$	20 × 26
Carte Panel	$7\frac{1}{8}$ × $12\frac{1}{8}$	19 × 33
Carte Royal	$9\frac{1}{8}$ × $11\frac{1}{8}$	23 × 29
Carte Portrait-Nature	$8\frac{1}{8}$ × $13\frac{1}{8}$	22 × 34
	$10\frac{1}{8}$ × $12\frac{1}{8}$	26 × 32
	$9\frac{1}{8}$ × $14\frac{1}{8}$	25 × 38
	$11\frac{1}{8}$ × $14\frac{1}{8}$	28 × 38
	$11\frac{1}{8}$ × $17\frac{1}{8}$	28 × 45
	$14\frac{1}{8}$ × $18\frac{1}{8}$	38 × 48
	$14\frac{1}{8}$ × $21\frac{1}{8}$	38 × 55
	$18\frac{1}{8}$ × $22\frac{1}{8}$	48 × 58
	$18\frac{1}{8}$ × $23\frac{1}{8}$	48 × 60

SIZING

Raw papers generally need to be sized before sensitising, because the size fills up the pores and keeps the image on the surface; in some cases, also, it increases the sensitiveness. As a general rule, sizing improves any raw paper. The sizes most used are arrowroot and gelatine, and the paper can be floated on one of these or brushed

over with the substance. In the case of gelatine the paper may be wholly immersed.

Arrowroot.—Of the many formulæ known, that due to Duchochois is as follows:—

Arrowroot	100	grs.	25	g.
Glucose	20	"	5	"
Water	10	oz.	1,000	ccs.

Mix the arrowroot and glucose with a little cold water, add the remainder hot, and boil up the whole in a porcelain dish. Cool, skim and strain through muslin before use. The above is suitable for the iron printing processes, namely, blue print, kallitype, etc. Other formulæ are given under separate headings.

Gelatine.—The following is suitable for printing with iron salts:—

Hard gelatine	50	grs.	25	g.
Water	10	oz.	1,000	ccs.
Alum	15	grs.	7.5	g.
Alcohol (pure)	2	oz.	220	ccs.

Soak the gelatine in about 9 oz. of the water for about an hour, heat until dissolved, dissolve the alum in the remaining water, add to the gelatine, and lastly the alcohol. After coating, dry for three minutes and coat again. For plain silver paper, dissolve 5 grs. of gelatine in 10 oz. of water, by aid of heat, and then dissolve therein 60 grs. of ammonium chloride. Immerse twice as above.

Gum Arabic.—For iron papers, prepare a weak solution of gum arabic (5 or 6 grs. to the oz. of water), and brush over the paper.

Resin, Iceland moss, and agar-agar are also used.

SKETCH EFFECTS

A term applied to pictures in which a part is photographic, and the remainder hand-work with pencil, crayon, etc. The usual plan is to work up the picture and then to copy and print duplicates. Sometimes the sketch effects are obtained by using platinotype or bromide paper, and developing only that part of the image desired by brushing on a developer mixed with glycerine. The usual plan is to make a print upon rough bromide paper, and to brush over any parts that are to be reduced with a "hypo"-ferricyanide or other reducer. The work calls for great care, and the print must be frequently rinsed in water and finally washed. It may be found easier to have the print half dry when brushing the reducer round delicate outlines, as the face, for example; but the methods employed depend upon the worker's skill. When portraits are taken specially for sketch effects a white background should be used. Sketch effects needing no pencil work are largely produced on platinotype paper owing to the facility with which such prints can be developed in parts with the ordinary platinotype developer mixed with glycerine, but bromide prints may, of course, be developed in a similar way. The objection to bromide paper for direct sketch effects by development is that the image is not faintly visible after printing, as it is upon platinum paper; but any part of the image may be reduced at a later stage.

The "hypo"-ferricyanide reducer is rather apt to stain, and the following will be found to be more serviceable:—

A. Iodine, resublimed	. . .	$\frac{1}{2}$ oz.	55 g.
Potassium iodide	. . .	1 "	110 "
Water	. . .	4 "	400 ccs.
B. Potassium cyanide	. . .	1 oz.	110 g.
Water	. . .	4 "	400 ccs.

Two-thirds fill a saucer with water, add a few drops of the A solution until the water is of a deep sherry colour, and then add just enough of the B solution to decolorise. Apply this with a tuft of cotton-wool, the work being done near to running water so that the reducer may be washed off quickly; the reducer leaves the paper white if allowed to act long enough. Reducers cannot be used for platinotype paper.

SKIAGRAM

A radiograph, or X-ray photograph.

SKIAGRAPHY

Radiography, or X-ray photography.

SKIN, EFFECTS OF CHEMICALS UPON

A few photographic chemicals in common use have a harmful effect upon the skin, as explained under separate headings. (See, for example, "Bichromate Disease," "Hygiene in Photography," "Metol," "Poisons and their Antidotes," etc.)

SKY NEGATIVES (See "Cloud Negatives.")

SKY, PRINTING IN (See "Clouds, Printing in.")

SKY SHADE

Commonly a hinged flap attached to the top of the lens hood, and used to screen the lens from the too bright light of the sky, and from the sun if present. It permits of the sky portion of the negative being so shaded that both foreground and sky are correctly exposed on the same negative.

SKY SHUTTER

This has the same purpose as the foreground shutter (*which see*).

SLIDE CARRIER

A bag or case to carry the dark-slides. Usually it is of leather lined with velvet or baize and fastening with straps or by a lock and key. Loose lined partitions are often provided to prevent the slides rubbing against each other. Sometimes there is also a pocket for the lens or lenses. Generally, however, both slides and lens are carried in the same bag as the camera.

Also a name given to the plate carrier.

SLIDE, DARK- (See "Dark-slide.")

SLIDE, LANTERN (See "Lantern Slides.")

SLIDE RULE, PHOTOGRAPHIC (Fr., *Règle mobile photographique*; Ger., *Photographisches Rechen-lineal*)

An instrument invented by A. Lockett, and shown at the Royal Photographic Society's Exhibition of 1909. It consists of a graduated right angle with a pivoted rule that may be made to move diagonally over it. By its use

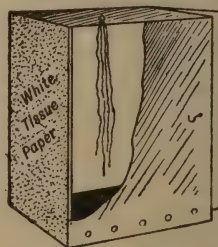
many photographic and optical calculations are quickly and automatically carried out, as, for instance, ascertaining measurements of objects from photographs; finding the conjugate foci for enlarging, copying, or reducing with a given lens; determining the length of studio necessary for portraiture with a stated objective; discovering the focal length obtained by combining two lenses, etc.

SLIP-IN MOUNTS

A mount composed of two boards, the upper having a cut-out opening, fastened together by the edges on three sides, while the fourth side is open to admit of a print being slipped in and adjusted in position behind the opening. This kind of mount is suitable only for glazed prints, or such as will lie quite flat. As no mountant is required, the gloss of the surface of a glazed print is unaffected. The mounts are made in standard sizes, and do not, therefore, admit of any trimming down of the print. As it is possible for the print to shift in the mount, it is well, when it is properly adjusted, to apply a touch of adhesive to two points on one edge of the print, and rub it down so that it adheres to the back board. This may be done by means of a knife slipped in at the opening through which the print was passed.

SMOKE BOX

A form of flash lamp for burning magnesium ribbon, and recommended by E. Seymour. The bottom of a box is replaced with a sheet of glass covered with white tissue-paper; this, in use, is the front of the box, as illustrated. The lid is hinged, as shown. Holes are cut at the base



Smoke Box

for ventilation, and the inner side of the top of the box is lined with tinplate and fitted with a hook or other device for holding the ribbon. The lid or door is closed immediately the ribbon is lighted, and the smoke box held in the hand and moved about as desired. Afterwards, the box can be taken out of doors and the smoke allowed to escape.

SNAPSHOTS

A common term designating so-called "instantaneous" exposures made with a camera held in the hand. Unfortunately, it suggests a random and unconsidered operation into which a large element of chance enters; whereas the mere fact that the actual exposure given was a short one does not imply that no thought, study, or observation was devoted to the subject. Moreover, the possibility of taking "snapshots" has



(Exposure $\frac{1}{800}$ second)

BY WALTER KILBEY, F.R.P.S.

FOCAL PLANE SHUTTER WORK

afforded the keen-eyed photographer numberless opportunities of recording transient effects and arrangements which would otherwise have been missed. It is to be hoped that the word "snapshot" will either be replaced by a more appropriate one, or will speedily live down the unfortunate significance it acquired in early days.

Absurd as it may seem, the notion is by no means obsolete that because a shutter will work at a certain high speed it will give a satisfactory result at that speed in all circumstances. This is a serious mistake, but a not uncommon one. In any given case there is a certain requisite exposure that can only be widely departed from to the detriment of the result. In the early days of so-called snapshot work the commonest fault was under-exposure. Since that time, however, there has been a tremendous increase in the sensitiveness of plates; lenses have been made with larger working apertures; and shutters have been improved in design and efficiency; and yet there are still occasions when the "snapshot" is necessarily under-exposed—either the lighting demanded a longer exposure than could be safely given in the hand, or an unduly short exposure had to be given on account of rapid movement in the subject. It is only in such cases that the development of snapshots differs from the normal. Harshness in the result is what has to be guarded against. The use in such circumstances of, say, a strong hydroquinone developer would probably result in dense, clogged high lights and shadow masses void of detail. Potassium bromide or other restrainer should be avoided, the developer should be well diluted, and plenty of time given to the developing action. While, of course, no possible alteration of developer can compensate for absence of effective light action, all the developable detail in the shadows should be secured. This may result in too great density in the high lights, but this may be modified afterwards with practically no detriment to the softer shadow detail, by the use of such a selective reducer as ammonium persulphate, or by mechanical reduction with Baskett's reducer or methylated spirit. The printing paper chosen should have been specially made to give softness of gradation from negatives of undue harshness. (See also "Focal Plane Shutter," "Hand Camera, Work with," and "Instantaneous Photography.")

SNOW AND HOAR FROST PHOTOGRAPHY

The characteristic of average snow views is the unusual degree of light contrast. Freshly fallen snow in direct sunlight causes the whitest of paper to appear grey by comparison. Thus, in a snow scene the tree-trunks, buildings, etc., appear much darker than usual, and should the photographer be led to under-expose he will get an inky blackness in the shadows and an intense whiteness in the snow. A broad expanse of freshly fallen and unbroken snow can rarely, if ever, be effectively photographed. The sparkling snow cannot be properly interpreted by white paper. In composing a snow view, spottiness and patchiness must be guarded against and special attention paid to the foreground. Plain freshly fallen snow rarely makes an interesting foreground, but tree stumps, gates, farm imple-

ments, etc., under a mantle of snow are often of great pictorial value, and cart-wheel ruts and lines of footprints will be found to serve admirably in breaking up a foreground; it is an old dodge to select the view-point and then to make a line of footprints to suit the composition of the desired picture. Of the greatest importance is the lighting. While a flat, dull sky with no sun may suit some subjects, more effective results are obtained in sunlight, and more particularly when the sun is near the horizon; it will be obvious, then, that the best-lighted effects are obtained in the early morning and in the afternoon. The low lighting breaks up broad expanses of level and white snow, and causes footprints, ruts, etc., in the foreground to stand out more prominently.

Either ordinary or isochromatic plates may be used, and they must be well backed, because of the risk of halation. Isochromatic plates used with a yellow screen may sometimes be of advantage, because of the frequent yellowness of winter light, and because a blue sky may be interpreted dark, so bringing out any hoar frost or snow effects on trees standing against the sky. Many of the snow-scene photographs taken in the Alps have black skies, owing to the use of a deep yellow ("many times") screen. The exposures are not much shorter than for ordinary views, because generally there are deep shadows in the scene, and under-exposure would cause these to be almost clear glass in the negative, and any attempt to force development for the purpose of bringing out detail would ruin the soft effect. An under-exposed negative of a snow-scene is practically useless, and it is better to expose fully and to get all detail possible in the shadows. Details are more important than density. The latter can be added to a negative, but details cannot. An exposure meter of the Watkins type may be used with success; it is held 12 or 15 in. from the body and turned towards the sky, but not in such a way that direct sunlight falls upon it. For an open scene the exposure so estimated may be divided by three or four; but when there are many trees or other deep shadows, the exposure may be increased up to the full time given by the meter.

With careless development the delicate gradation and detail in the snow is likely to be blocked up and rendered unprintable. Mrs. Aubrey Le Blond, who has had a long experience in snow and ice photography, uses a metol-hydroquinone developer. She pours it into two half-pint bottles, one labelled "Old" and the other "New." The former is used over and over again for developing, and as it becomes used up it is kept full by adding from the new solution. The method is economical and gives excellent results. Sir W. Abney recommends beginning with—

Ammonia	30 mins.	6 ccs.
Potass. or amm. bromide .	50 grs.	12 g.
Pyro	1 "	24 "
Water	10 oz.	1,000 ccs.

Allow this to act until all detail is out, and finish with—

Ammonia	30 mins.	6 ccs.
Bromide	80 grs.	19 g.
Pyro	40 "	9.5 "
Water	10 oz.	1,000 ccs.

SOAP (Fr., *Savon*; Ger., *Seife*)

Soap is used as a lubricant when burnishing prints. Hofbauer has stated that the addition of Castile soap to a pyro developer prevents fog in cases where excessive alkali is used. A solution of 100 grs. of the soap in 10 oz. of water is used instead of plain water when making up the developer.

A good soap should always be used for washing the hands after working with such chemicals as amidol, metol, potassium bichromate, etc.

SODA, ALUM (See "Alum.")

SODA, CAUSTIC (See "Sodium Hydrate.")

SODA SALTPETRE (See "Sodium Nitrate.")

SODIUM ACETATE (Fr., *Acetate de soude*; Ger., *Essigsäures Natron*)

Synonym, acetate of soda. $\text{NaC}_2\text{H}_3\text{O}_2 \cdot 3\text{H}_2\text{O}$. Molecular weight, 136. Solubilities, 1 in 1 water, 1 in 23 alcohol. Obtained by neutralisation of acetic acid with sodium carbonate or hydrate. Colourless transparent efflorescent crystals. It is used principally in the gold toning bath.

Twice-fused sodium acetate is also occasionally used; it has a slight alkaline reaction which makes the toning bath act more quickly, and at the same time the double-fusing destroys any organic impurities, such as sodium formate, etc., which tend to reduce the gold.

SODIUM BIBORATE (See "Sodium Borate.")

SODIUM BICARBONATE (Fr., *Bicarbonate de soude*; Ger., *Doppelt Kohlensäures Natron*)

Synonyms, monosodic carbonate, acid sodium carbonate, NaHCO_3 . Molecular weight, 84. Solubility, 1 in 11.3 water, insoluble in alcohol. It takes the form of rhombic tabular crystals or fine white powder, obtained by passing a stream of carbonic acid gas through a solution of carbonate of soda. Occasionally it is used in gold toning, but it must not be confounded with sodium carbonate.

SODIUM BICHROMATE (Fr., *Bichromate de soude*; Ger., *Doppelt Chromsäures Natron*)

Synonyms, dichromate of soda, acid sodium chromate. $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$. Molecular weight, 298. Solubilities, 1 in 1 water, insoluble in alcohol. It consists of red deliquescent crystalline fragments, obtained in a similar manner to the potassium salt, and used for the same purposes. 1.10 parts of sodium bichromate will replace 1 part of the potassium salt.

In process work, this salt has been suggested as a substitute for the potassium and ammonium salts in sensitising, but it has no advantages; indeed, its deliquescence is a disadvantage.

SODIUM BISULPHITE (Fr., *Bisulfite de soude*; Ger., *Säures Schwefligsäures Natron*, *Natrium Bisulfit*)

Synonym, acid sulphite of soda. NaHSO_3 . Molecular weight, 104. Solubilities, 1 in 3.5 water, 1 in 70 alcohol. It is a white, crystalline powder or prismatic crystals, with faint sulphurous odour, obtained by passing sulphurous acid gas through a solution of carbonate of soda.

It is used for acidulating fixing baths and solutions of sodium sulphite, and for preserving stock solutions of developers.

A thick, yellow liquid, known as bisulphite or acid sulphite lye, ozone bleach (Fr., *Bisulfite lye*; Ger., *Sulfillauge*), which is a saturated solution of sodium bisulphite, is obtainable commercially. This can be made as follows:—

Sodium sulphite	10 oz.	550 g.
Warm distilled water	20 "	1,000 ccs.

Dissolve, and add slowly when cold—

Sulphuric acid	1½ oz.	87.5 ccs.
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SODIUM BORATE (Fr., *Borate de soude*; Ger., *Borax*, *Borsäures Natron*)

Synonyms, borax, sodium tetraborate, pyroborate, biborate, tincal or tinkal. $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$. Molecular weight, 382. Solubilities, 1 in 17 cold, 1 in .5 boiling water, insoluble in alcohol, very soluble in glycerine. It is in the form of hard, white crystals or powder, obtained from the native borax or neutralisation of native boric acid. It is used principally in gold toning and as an accelerator with eikonogen and hydroquinone developers.

SODIUM BROMIDE (Fr., *Bromure de soude*; Ger., *Bromnatrium*)

Synonyms, bromide of soda or sodium. NaBr . Molecular weight, 103. It is a white crystalline powder, which readily absorbs moisture from the air without deliquescing, and cakes into a hard, semi-translucent mass. It is obtained in the same way as the potassium salt, and it is occasionally used in emulsion making, but its hygroscopic qualities render it less certain than the potassium and ammonium salts.

SODIUM CARBONATE (Fr., *Carbonate de soude*; Ger., *Soda*, *Kohlensäures Natron*, *Natriumcarbonat*)

Synonyms, soda, washing soda, carbonate of soda. $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$. Molecular weight, 286. Solubilities, 1 in 1.6 water, insoluble in alcohol. It is in the form of large prismatic crystals or fine white powder, obtained on a large scale by converting salt into sodium sulphate, and then decomposing the latter by roasting with limestone and coal. It is the favourite alkali for development.

Washing soda is an impure variety which contains variable quantities of water, sodium sulphate, and other impurities.

An anhydrous salt (Fr., *Carbonate de soude anhydre*; Ger., *Kohlensäures Natron Wasserfrei*), Na_2CO_3 , molecular weight 106, is obtained as a fine white powder by heating the ordinary carbonate. Practically 37 parts of the anhydrous salt are equal to 100 of the ordinary soda.

SODIUM CHLORIDE (Fr., *Chlorure de soude*, *Selmarin*; Ger., *Chlornatrium*, *Sal Gemmae*)

Synonyms, muriate or chloride of soda, salt, common or table-salt. NaCl . Molecular weight, 58.5. Solubilities, 1 in 2.7 water, almost insoluble in alcohol. It is a fine white crystalline powder or transparent crystals, obtained native or by purification from sea water. It is used to prepare chloride emulsions and as a weaker restrainer than the alkaline bromides in developers.

SODIUM CHLOROPLATINATE (Fr., *Chloroplatinate de soude*, *Chlorure double de sodium et de platine*; Ger., *Natrium-platin-chlorid*)

$\text{PtCl}_2 \cdot 2\text{NaCl} \cdot 6\text{H}_2\text{O}$ or $\text{PtCl}_2 \cdot \text{Na}_6\text{H}_4\text{O}_6$. Molecular weight, 560.4. Solubilities, soluble in water and alcohol. It is a yellow crystalline powder, obtained by adding sodium chloride to platinum chloride. It is used in the platinotype process to produce greater contrast in the prints.

SODIUM CITRATE (Fr., *Citrate de soude*; Ger., *Citronensaures Natron*)

Synonym, citrate of soda, neutral citrate of soda. $2\text{Na}_2\text{C}_6\text{H}_5\text{O}_7 \cdot 11\text{H}_2\text{O}$. Molecular weight, 714. Solubilities, 1 in 1.1 water, slightly soluble in alcohol. It is a white crystalline or granular powder, obtained by neutralising citric acid with sodium carbonate. It is used as a preservative for albumen paper, to form silver citrate in printing-out emulsions and as a restrainer in developers.

In consequence of its deliquescent nature it is best prepared in solution by adding about 266 grs. or g. of sodium carbonate to 162 grs. or g. of citric acid in solution; the result will be 480 grs. or g. of sodium citrate; about 3 oz. or 1,440 ccs. of water should be used, and the total bulk made up to 4 oz. or 1,920 ccs., when the solution will be 25 per cent. A little salicylic acid will prevent it from growing mouldy.

SODIUM FLUORIDE (Fr., *Fluorure de soude*; Ger., *Natrium Fluorid*)

Synonym, fluoride of soda. NaF . Molecular weight, 42. Solubilities, 1 in 23 water. It takes the form of clear lustrous crystals or white powder, obtained by neutralising hydrofluoric acid with carbonate of soda. It is used like the potassium salt to strip the film from gelatine negatives.

SODIUM FORMATE (Fr., *Formiate de soude*; Ger., *Ameisensaures Natrium*)

Synonym, formiate of soda. $\text{NaCHO}_2 \cdot \text{H}_2\text{O}$. Molecular weight, 86. It is a white deliquescent crystalline powder, obtained by neutralising formic acid with soda. It has been suggested as an ingredient in the platinum and gold toning baths.

SODIUM HYDRATE (Fr., *Soude caustique*; Ger., *Aetznatron*)

Synonyms, caustic soda, sodium hydroxide. NaOH . Molecular weight, 40. Solubilities, 1 in 1.62 water, soluble in alcohol. It is poisonous, the antidote being water, followed by lemon or lime juice and milk or oil. It usually occurs in white sticks or lumps obtained by decomposing sodium carbonate with lime. It is used as an accelerator in development. It should be kept in bottles with rubber or paraffin stoppers, and should not be handled with the fingers.

SODIUM HYPOCHLORITE (Fr., *Eau de Javelle*; Ger., *Javellesche Lauge*.)

Synonyms, eau de Javelle, Labarraque's solution, chlorinated solution of soda, ozone bleach. It is a liquid possessing a strong chlorine odour, containing sodium hypochlorite, salt, and car-

bonate of soda, obtained by decomposing bleaching powder with sodium carbonate:—

Sodium carbonate	. 1 oz.	110 g.
Bleaching powder	. 320 grs.	73 "
Water to .	. 4 oz.	400 ccs.

Shake thoroughly, allow to stand for an hour, and filter. It is used to remove stains from negatives and destroy the last traces of "hypo."

SODIUM HYPOSULPHITE (Fr., *Hyposulfite de soude*; Ger., *Fixirnatron*, *Unterschweflig-saures Natron*)

Synonyms, "hypo," sodium thiosulphate, hyposulphite of soda. $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$. Molecular weight, 248. Solubilities, 1 in .65 water, insoluble in alcohol. It is in the form of white transparent crystals, obtained by various processes on a large scale, in which sodium sulphite is the starting point. Its chief use is as a fixing agent for negative and positive work.

SODIUM HYPOSULPHITE, TESTING FOR

The water in which negatives, etc., are being washed after fixing is often tested to ascertain whether "hypo" is present; that is to say, whether the negatives, etc., have been washed long enough to remove all the "hypo." The best method of so doing is to use the following solution:—

Potassium carbonate	. 5 grs.	1 g.
Potassium permanganate	$\frac{1}{2}$ "	"1"
Distilled water	. 10 oz.	1,000 ccs.

A few drops of this pinkish-purple liquid added to a sample of the washing water will turn green when "hypo" is present; the smaller the proportion of "hypo" in the water, the longer the change takes; and if there are very slight traces present, the change will be to blue, not green. The water to be tested should be the last the negatives or prints have been washed in, and preferably that which has been standing still for about ten minutes with the negatives therein; take the water as much as possible from the bottom of the tank.

For the starch iodide test, powder and boil a piece of starch about the size of a pea in two or three drams of water until a clear solution is obtained; add one drop of a tincture of iodine (iodine dissolved in alcohol), which will produce a dark blue colour. Fill one test tube with distilled water, and another with the water to be tested, and add to each tube one drop of the solution. If any "hypo" be present, the blue colour will disappear. The tubes should be warmed slightly and examined side by side against white paper, as the test is very delicate.

The Bannon or silver test is to let a negative or print drain into a test tube, then heat the drainings, and add a few drops of a silver nitrate solution. A black precipitate will be formed if $\frac{1}{10000}$ part of "hypo" is present, while a smaller amount will give a yellowish precipitate.

A rough and ready test is to taste the drainings; the sweeter the taste the more "hypo" present. For the zinc and sulphuric acid test, dilute the acid to twice its bulk with water; put some zinc into a flask, with the washing water, and add the dilute acid. If "hypo" is present, sul-

phuretted hydrogen is produced, as demonstrated by holding over the flask a piece of blotting-paper moistened with a solution of lead acetate, which will be blackened. Chromic acid also gives a test; about 4 grs. are dissolved in 5 oz. of water, and a few drops of sulphuric acid added. If on adding the washing water a greenish cloud appears, "hypo" is present. Potassium ferricyanide in a weak solution and ferric chloride in a stronger solution, mixed in equal proportions and added to the washing water, gives a greenish colour if "hypo" is present.

SODIUM IODIDE (Fr., *Iodure de soude*; Ger., *Iodnatrium*)

Synonym, iodide of soda. NaI . Molecular weight, 150. Solubilities, 1 in .5 water, 1 in 3 alcohol. It is in the form of white crystalline powder or cubical crystals. Very rarely used in place of the other iodides in consequence of its deliquescent nature.

SODIUM NITRATE (Fr., *Azotate de soude*; Ger., *Salpetersaures Natron*)

Synonym, cubic, Chili, or soda nitre or saltpetre. NaNO_3 . Molecular weight, 85. Solubilities, 1 in 1.1 water, 1 in 100 alcohol. It takes the form of colourless rhombohedral crystals, obtained native. It is rarely used in photography, though it is stated to give a rich brownish black tone to developed silver images.

SODIUM NITRITE (Fr., *Azotite de soude*; Ger., *Salpetrigsaures Natron*)

Synonym, nitrite of soda. NaNO_2 . Molecular weight, 69. Solubilities, 1 in 1.4 water, slightly soluble in alcohol. It is in the form of white opaque sticks or colourless crystals, prepared by fusing the nitrate or neutralising nitrous acid. Occasionally used to obtain a permanent standard photometer paper and in the diazotype process. It must not be confounded with the nitrate.

SODIUM NITROPRUSSIDE (Fr., *Nitroprussiate de soude*; Ger., *Nitroprussidnatrium*)

Synonym, sodium nitroprussiate. $\text{Na}_2\text{Fe}(\text{CN})_6(\text{NO})_2\text{H}_2\text{O}$. Molecular weight, 298. Solubilities, 1 in 2.5 water, soluble in alcohol. It is in the form of deep ruby red transparent crystals, obtained by the action of nitric acid on potassium ferricyanide. It is one of the most light-sensitive iron salts, and is occasionally used for iron printing and photometric work.

SODIUM OXALATE (Fr., *Oxalate de soude*; Ger., *Oxalsaures Natron*)

Synonym, oxalate of soda. $\text{Na}_2\text{C}_2\text{O}_4$. Molecular weight, 134. Solubilities, 1 in 33 water, insoluble in alcohol. It is a white crystalline powder, obtained in the same way as the corresponding potassium salt. It is rarely used, on account of its low solubility, but is occasionally employed in the platinotype process.

SODIUM PERSULPHATE (Fr., *Persulphate de soude*; Ger., *Ueberschweifelsaures Natrium*)

$\text{Na}_2\text{S}_2\text{O}_8$. Molecular weight, 238. Soluble in water. It is a white crystalline powder, obtained like the corresponding potassium salt, and used for the same purposes.

SODIUM PHOSPHATE (Fr., *Phosphate de soude*; Ger., *Phosphorsaures Natron*)

Synonyms, phosphate of soda, disodium orthophosphate. $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$. Molecular weight, 358. Solubilities, 1 in 6.7 water, insoluble in alcohol. It takes the form of colourless transparent crystals or white granular powder, obtained by treating calcium phosphate with carbonate of soda. It is used in the gold toning bath.

SODIUM PYROBORATE (See "Sodium Borate.")

SODIUM SILICATE (Fr., *Silicate de soude*; Ger., *Natronwasserglas*)

Synonyms, soluble glass, soda water-glass. $\text{Na}_2\text{SiO}_3 + \text{Aq}$. It is in the form of white to bluish grey hard flat pieces, obtained in the same manner as the corresponding potassium salt and used for the same purposes. It is also met with commercially as a syrupy yellowish liquid containing 20 per cent. silica and 10 per cent. soda.

In process work, sodium silicate is used either alone or in combination with albumen or other ingredients as a substratum to make the gelatine film hold better on the collotype printing plate. The substratum may consist of water $3\frac{1}{2}$ oz., gelatine 46 grs., sodium silicate $\frac{1}{2}$ oz., chrome alum, 8 grs. The silicate is added after the other ingredients are mixed and dissolved.

SODIUM SULPHANTIMONIATE (Fr., *Sulfoantimoniate de soude, Sel de Schlippe*; Ger., *Schlippesche Salz*)

Synonyms, Schlippe's salt, sodium thioantimonate. $\text{Na}_3\text{SbS}_4 \cdot 9\text{H}_2\text{O}$. Molecular weight, 479. Solubility, 1 in 3 water. It is in the form of large colourless or yellow crystals, obtained by boiling milk of lime, sulphide of antimony, and carbonate of soda. It is used to tone bromide prints and for darkening negatives after mercurial bleaching. It is rapidly decomposed by absorption of carbonic acid from the air.

SODIUM SULPHATE (Fr., *Sulfate de soude*; Ger., *Schwefelsaures Natron*)

Synonym, Glauber's salt. $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$. Molecular weight, 322. Solubilities, 1 in 3 water, insoluble in alcohol. It is in the form of colourless efflorescent crystals, obtained as a by-product in the salt cake process. It is used to prepare barium sulphate.

SODIUM SULPHIDE (Fr., *Sulfure de soude*; Ger., *Natriumsulfid*)

Synonym, sulphide of soda. $\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$. Molecular weight, 240. Solubility, soluble in water. It consists of colourless, transparent, deliquescent crystals, obtained by fusing sodium carbonate with sulphur. It is used for sulphide or sepia toning of bromide prints. It should not be kept near any sensitive materials, and the bottle should be well stoppered.

In process work, a 5 per cent. solution of sodium sulphide is used as a blackener in the intensification of wet collodion negatives, in preference to the ammonium sulphide. Being a dry salt, it is more portable and convenient to handle.

SODIUM SULPHITE (Fr., *Sulfite de soude*; Ger., *Natriumsulfid*)

Synonym, sulphite of soda. $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$. Molecular weight, 252. Solubilities, 1 in 2.2 water, slightly soluble in alcohol. It takes the form of colourless crystals or powder, obtained by passing sulphurous acid gas over damp sodium carbonate. The crystals are efflorescent and are readily oxidised to sulphate. It is an energetic absorbent of oxygen, and is therefore used to preserve developing agents; the effloresced salt should not be used for this purpose, as it is a weaker preservative, and the sulphate acts as a restrainer.

The anhydrous salt—(Fr., *Sulfite de soude anhydre*; Ger., *Wasserfrei Natriumsulfid*), Na_2SO_3 ; molecular weight, 126; solubility, 1 in 4 water—occurs as a fine white powder, and is prepared by heating the crystalline sulphite to 212°F . One part of the anhydrous salt is equal to 2 parts of the crystalline.

SODIUM TARTRATE (Fr., *Tartrate de soude*; Ger., *Weinsaures Natron*)

$\text{Na}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$. Molecular weight, 230. It consists of white crystals, obtained by neutralising tartaric acid with sodium carbonate or hydrate. Occasionally it is used in printing-out emulsions.

SODIUM THIOSULPHATE (See "Sodium Hyposulphite.")**SODIUM TRIBASIC PHOSPHATE** (Fr., *Phosphate tribasique de soude*; Ger., *Dreibasisch Phosphorsaures Natron*)

Synonym, tribasic phosphate of soda, normal sodium or trisodic orthophosphate. $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$. Molecular weight, 380. Solubilities, 1 in 5.1 water, insoluble in alcohol. It consists of large, six-sided, colourless crystals, obtained by adding caustic soda to sodium phosphate. It has been suggested by Lumière as a substitute for the caustic and carbonate alkalis in developers, but has not found general use. Add 453 grs. or g. of sodium phosphate to 51 grs. or g. of caustic soda, both in solution, and make the total bulk to 10 oz. or 4,800 ccs., and the result will be a 10 per cent. solution of the tribasic salt.

SODIUM TUNGSTATE (Fr., *Tungstate de soude*; Ger., *Wolframsaures Natron*)

Synonyms, tungstate of soda, sodium wolframate. $\text{Na}_4\text{W}_{12}\text{O}_{41} \cdot 28\text{H}_2\text{O}$. Solubilities, 1 in 4 water, insoluble in alcohol. It takes the form of transparent tabular crystals, prepared by fusing wolframite with sodium carbonate. It is used in gold toning.

SODIUM VANADATE (Fr., *Vanadate de soude*; Ger., *Natriumvanadat*)

Synonym, sodium orthovanadate. Na_3VO_4 . Molecular weight, 184. Soluble in water. It is a white crystalline powder, which is rarely used, but which has been suggested to increase contrast in printing-out emulsions.

SOFTNESS

A term generally used to indicate an abundance of middle tones without loss of detail in

either the high lights or the shadows. The absence of softness means harshness; its exaggeration produces flatness. Under-exposure and over-development will give the former; over-exposure and under-development the latter. The selection of special printing papers aids in securing a bright result from a soft negative, or a soft result from a hard negative, as the case may be.

SOL LAMP

A lamp in which vaporised methylated spirit is burnt in an incandescent mantle. The spirit is contained in a reservoir, which may be raised or lowered on an upright rod to adjust the pressure, a bend in the supply tube being carried over the burner so that the spirit continues to be vaporised once the lamp is alight. To start the lamp, a band of asbestos soaked in spirit is placed below the burner and ignited. The lamp is suitable for enlarging and for use in the optical lantern.

SOLAR CAMERA (Fr., *Chambre solaire*, *Chambre à héliostat*; Ger., *Solar Kamera*, *Sonnenkamera*)

An apparatus for enlarging by the direct rays of the sun, now practically obsolete. There were two forms, one resembling an ordinary daylight enlarging camera, while the other had, in addition, a condenser in front of the negative to concentrate the rays. Sometimes a heliostat was used to keep the sun's rays constantly directed on the condenser.

SOLAR ENLARGING

Sometimes referred to as solar printing. Enlarging with the solar camera, that is, by sunlight.

SOLAR PHOTOGRAPHY (See "Sun, Photographing the.")**SOLAR SPECTRUM** (See "Spectrum, Solar.")**SOLARISATION**

A term with many photographic meanings. It is synonymous with reversal (*which see*), and it is also applied to halation and to bronzing.

SOLUBILITIES

The table on pages 502-505 gives a list of the chief photographic chemicals, with formulæ, molecular weights, and solubilities in cold and hot water. For other information, consult articles under separate headings.

SOLUBLE GLASS (See "Potassium Silicate" and "Sodium Silicate.")**SOLUTIONS, CONCENTRATED**

Solutions made up of a greater strength than that required for use; developers, for example, to which water is added before use. They are often confused with "saturated solutions," which, indeed, are concentrated solutions, although a concentrated solution need not be saturated. Concentrated solutions keep better than those diluted to working strength, and almost any photographic solution can be made up in a concentrated form simply by using less

TABLE OF FORMULÆ AND SOLUBILITIES OF PHOTOGRAPHIC CHEMICALS

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TABLE OF FORMULÆ AND SOLUBILITIES OF PHOTOGRAPHIC CHEMICALS—continued

Name	Chemical Formula	Molecular weight	No. of parts of cold water in which 1 part is soluble	No. of parts of hot water in which 1 part is soluble	Name	Chemical Formula	Molecular weight	No. of parts of cold water in which 1 part is soluble	No. of parts of hot water in which 1 part is soluble
Calcium carbonate (chalk) ...	CaCO_3	100	insol.	insol.	Erythrosine ...	$\text{C}_{12}\text{H}_8(\text{COC}_2\text{H}_5)_4\text{O}$	660	sol.	—
" chloride (cryst.) ...	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	219	1·25	v. sol.	Ether... ..	$\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$	74	12	—
" chromate ...	$\text{CaCrO}_4 \cdot 2\text{H}_2\text{O}$	111	1·4	sol.	Ferric ammonio-citrate, brown	$4\text{FeC}_2\text{H}_3\text{O}_7 \cdot 3(\text{NH}_4)_2\text{C}_6\text{H}_5\text{O}_7 \cdot 3\text{Fe}(\text{OH})_3$	2030	4	—
" hydrochloride ...	$\text{Ca}(\text{OH})_2$	102	700	sol.	" ammonio-citrate, green	$5\text{FeC}_2\text{H}_3\text{O}_7 \cdot 2(\text{NH}_4)_2\text{C}_6\text{H}_5\text{O}_7 \cdot 8\text{H}_2\text{O}$	1956	sol.	—
" hypochlorite ...	$\text{Ca}(\text{OCl})_2$	153	400	—	" ammonio-oxalate	$\text{C}_2\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O}$	892	21	—
" oxide (quicklime) ...	CaO	56	380	450	" ammonio-sulphate	$\text{Fe}_3(\text{C}_2\text{H}_3\text{O}_7)_2 \cdot 3(\text{NH}_4)_2\text{C}_6\text{H}_5\text{O}_7 \cdot 6\text{H}_2\text{O}$	348	5	—
" sulphate ...	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	172	700	insol.	" chloride (lump)	$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$	270·5	v. sol.	—
Calomel (see Mercurous chloride)	$\text{C}_2\text{H}_5\text{O}$	152	700	insol.	" ferrocyanide (Prussian blue)	$\text{Fe}_4\text{Fe}(\text{C}_2\text{N}_6)_3$	860	insol.	—
Camphor ...	CS_2	76	insol.	insol.	" oxalate	$\text{Fe}_2(\text{C}_2\text{O}_4)_3$	376	v. sol.	—
Carbon disulphide ...	COCl_2	156	insol.	insol.	" potassium oxalate	(See Potassium ferric oxalate)	—	—	—
Carbon tetrachloride ...	$\text{C}_2\text{H}_5\text{O}$	504	insol.	insol.	" sodium oxalate	$\text{Fe}(\text{C}_2\text{O}_4)_2 \cdot 2\text{Na}_2\text{C}_2\text{O}_4 \cdot 11\text{H}_2\text{O}$	976	1·69	·55
Chalk (see Calcium carbonate)	$(\text{C}_2\text{H}_5\text{O})_n$	162·8	sol.	sol.	" sulphate	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	563	sol.	—
Cellulose ...	$(\text{C}_2\text{H}_5\text{O})_n \cdot 3\text{COOH}$	207·8	insol.	insol.	Ferrous acetate	$\text{Fe}(\text{CH}_3\text{COO})_2$	174	sol.	—
Ceric sulphate ...	$\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$	404	sl. sol.	sl. sol.	" ammonium sulphate	$\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	392	3	—
Chinoline blue or cyanine ...	$\text{C}_2\text{H}_5\text{N}$	544	sl. sol.	sl. sol.	" chloride (dry)	FeCl_3	127	2	v. sol.
Chloral hydrate ...	$\text{C}_2\text{H}_5\text{N} \cdot \text{NaCl}$	380·5	—	—	" chloride (cryst.)	$\text{FeCl}_3 \cdot 4\text{H}_2\text{O}$	199	1·4	v. sol.
Chloride of lime (see Calcium hypochlorite)	$\text{CCl}_3\text{CH}(\text{OH})_2$	165·5	v. sol.	v. sol.	" nitrate	$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	536	6	—
Chlorine ...	Cl	35·5	absorbed by 1 to 2·5 vols.	—	" oxalate	$\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	180	4500	3800
Chloroform ...	CHCl_3	119·5	200	—	" potassium oxalate	$\text{K}_2\text{Fe}(\text{C}_2\text{O}_4)_2 \cdot \text{H}_2\text{O}$	278	1·8	—
Chrome alum (see Alum, chrome)	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	" sulphate	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	332	insol.	—
Chrysoidine ...	$\text{Cu}(\text{C}_2\text{H}_3\text{O}_7)_2 \cdot \text{H}_2\text{O}$	238	14	—	Fluorescein ...	$\text{C}_2\text{H}_4(\text{OH})_2$	—	sl. sol.	—
Cobalt chloride ...	CuBr_2	199·5	v. sol.	—	Formaline ...	$\text{C}_2\text{H}_5\text{OH}$	92	sol.	—
Copper acetate (verdigris) ...	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$	223·5	v. sol.	—	Glycerine ...	$\text{C}_2\text{H}_5\text{OH} \cdot \text{NH}_2\text{CH}_2\text{COOH}$	107	insol.	—
" bromide ...	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	245·5	2·5	—	" chloride	$\text{AuCl}_3\text{HCl} \cdot \text{H}_2\text{O}$	340	sol.	—
" chloride ...	Cu_2O	170·5	—83	—	Gold chloride, brown	$\text{AuCl}_3 \cdot 2\text{H}_2\text{O}$	412	v. sol.	—
" sulphate (blue vitriol) ...	Cu_2O	245·5	2·5	—	" potassium chloride	$\text{KAuCl}_4 \cdot 2\text{H}_2\text{O}$	444	sol.	—
" sulphate and ammonia chloride	Cu_2O	245·5	2·5	—	" sodium chloride	$\text{NaAuCl}_4 \cdot 2\text{H}_2\text{O}$	398	v. sol.	—
Corrosive sublimate (see Mercury chloride)	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	Gun-cotton (tri-nitrate cellulose)	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NO}_2)_3$	504	insol.	—
Cyanine (see Chinoline blue)	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	" hydramine	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_2)_2\text{C}_6\text{H}_5$	579	insol.	—
Dextrine (see Cellulose)	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	Hydrazine ...	NH_2NH_2	32	—	—
Diamidophenol (see Amidol)	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	Hydrogen ...	H_2	2	—	—
Diamidoresorcin ...	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	" peroxide ...	H_2O_2	34	sol.	—
Dinitro-naphthol ...	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	" sulphide ...	H_2S	34	sol.	—
Diphenal ...	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	Hydroquinone	$\text{C}_6\text{H}_4(\text{OH})_2$	110	16	9
Edinol ...	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	Iodine ...	I_2	254	—	e. a.
Eikonogen ...	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	Iridium chloride	$\text{IrCl}_3 \cdot 2\text{KCl}$	289·5	5000	—
Eosine ...	$\text{C}_2\text{H}_5\text{N}_2\text{C}_2\text{H}_4(\text{NH}_4)_2$	217·7	sol.	—	" potassium tetrachloride	Na_2IrCl_6	484	—	—
		708	sol.	—	" sodium tetrachloride	Na_2IrCl_6	484	—	—
			sol.	—	" tetrachloride	IrCl_4	355	—	—

TABLE OF FORMULÆ AND SOLUBILITIES OF PHOTOGRAPHIC CHEMICALS—continued

Name	Chemical Formula	Molecular weight	No. of parts of cold water in which 1 part is soluble	No. of parts of hot water in which 1 part is soluble	Name	Molecular weight	No. of parts of cold water in which 1 part is soluble	No. of parts of hot water in which 1 part is soluble
Kaolin...	$\text{Al}_2\text{Si}_2\text{O}_5 + 2\text{H}_2\text{O}$	258.8	insol.	insol.	Potassium bitartrate	198	—	—
Lead acetate (sugar of lead)	$\text{Pb}(\text{CH}_3\text{COO})_2 \cdot 3\text{H}_2\text{O}$	379	insol.	insol.	disulphite	120	sol.	—
" chromate	PbCrO_4	323	insol.	insol.	boro-tartrate	214	1.75	v. sol.
" nitrate	$\text{Pb}(\text{NO}_3)_2$	331	insol.	insol.	bromide...	119	1	—
" oxide	PbO	253	insol.	insol.	carbonate (dry)	138	9	.64
Lithia, caustic (see Lithium hydrate)					K_2CO_3	122.5	16.7	2
Lithium bromide	LiBr	87	6	4	chloride...	74.5	3	1.75
" carbonate	Li_2CO_3	74	75	138	chloroplatinite	413.4	6	v. sol.
" chloride	LiCl (cryst. has $2\text{H}_2\text{O}$)	42.5	1.25	8	chromate	194	2	1.2
" hydrate	LiOH	24	61	2	chromic sulphate	—	—	—
" iodide	LiI	131	1	1	Alum, chrome	—	—	—
Magnesium bromide...	$\text{MgBr}_2 \cdot 6\text{H}_2\text{O}$	201	insol.	insol.	citrate	342	6	v. sol.
" carbonate	MgCO_3	84	insol.	insol.	cyanide	65	2	v. sol.
" chloride	$\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	202	6	1.5	ferric oxalate	491	10	—
" iodide	$\text{MgI}_2 \cdot 8\text{H}_2\text{O}$	421	1	1.75	ferrocyanide	329	2.5	1.3
" sulphate (Epsom salt)	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	246	15	15	ferrous oxalate	428	6	2
Manganese dioxide	MnO_2	87	insol.	insol.	fluoride	38	insol.	—
" sulphate	$\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$	223	8	1	hydrate	56	1	v. sol.
Mercury	Hg	200	—	—	iodide	266	1.75	v. sol.
" chloride (mercuric)	HgCl_2	271	16	1.8	metabisulphite	166	3	v. sol.
" chloride (mercurous)	Hg_2Cl_2	471	insol.	insol.	nitrate	222	3	—
" iodide (mercuric)	HgI_2	454	insol.	insol.	nitrite	101	38	3
" potassium iodide (sol.)	$\text{HgI}_2 \cdot 2\text{KI}$	786	—	—	oxalate	85	1	v. sol.
" sulphocyanide	$\text{Hg}(\text{SCN})_2$	316	sl. sol.	sl. sol.	percarbonate	184	3	v. sol.
Metol (mono-methyl-para-amido-phenol)	$\text{C}_6\text{H}_4(\text{OH})(\text{NHCH}_3)\text{C}_6\text{H}_4(\text{OH})_2$	344	sol.	—	permanganate	138.5	15	dec.
Ortol	$\text{C}_6\text{H}_4\text{OHNHCH}_3\text{C}_6\text{H}_4(\text{OH})_2$	344	sol.	—	persulphate	316	16	5
Palladium chloride	$\text{PdCl}_2 \cdot 2\text{KCl}$	326.5	sol.	sol.	silicate	174	50	—
Para-amido-chloride					and sodium tartrate	154	3	v. sol.
Para-amido-phenol (see Para-amido-phenol hydrochlorate)					sulphide	174	1.4	v. sol.
Para-amido-phenol hydrochlorate	$\text{C}_6\text{H}_4\text{OHNHCH}_3\text{C}_6\text{H}_4(\text{OH})_2$	344	sol.	sol.	sulphocyanide	97	.46	v. sol.
Para-formaldehyde	$\text{C}_6\text{H}_4\text{H}_2\text{N}_2\text{O}$	234	—	—	$\text{C}_6\text{H}_4(\text{OH})_2$	110	1.25	v. sol.
Para-rosaniline (tri-amido-phenyl carbazol)	C_6H_3	177.5	—	—	$\text{C}_6\text{H}_3(\text{NO}_2)_3 + \text{C}_{12}\text{H}_{11}\text{O}_7$	947	insol.	—
Pentone					$\text{C}_6\text{H}_4(\text{OH})_2 + \text{C}_6\text{H}_4(\text{OH})$	263	100	—
Phenol (see Acid, carbolic)					$\text{C}_6\text{H}_5\text{O}_2\text{SO}_3\text{Na}$	211	—	—
Platino-potassium chloride or chloroplatinate	K_2PtCl_6	413.4	6	—	$\text{C}_6\text{H}_4(\text{OH})_2$	110	.6	—
Platinum bichloride	PtCl_4	264.4	insol.	—	Quinomet	—	—	—
" perchloride	$\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$	516.4	1	—	Quinone (see Benzoquinone)	—	—	—
Potassa (see Potassium hydrate)					" sodium-sulphonate	—	—	—
Potassium, aluminium sulphate (see Alum potash)					Resorcin	—	—	—
" bicarbonate	KHCO_3	100	3	dec.	Rochelle salt (see Potassium and sodium tartrate)	—	—	—
" bichromate	$\text{K}_2\text{Cr}_2\text{O}_7$	294	10	1	Rodinal (see Para-amido-phenol hydrochlorate)	—	—	—

TABLE OF FORMULÆ AND SOLUBILITIES OF PHOTOGRAPHIC CHEMICALS.—continued

Name	Chemical Formula	Molecular weight	No. of parts of cold water in which 1 part is soluble	No. of parts of hot water in which 1 part is soluble	Name	Chemical Formula	Molecular weight	No. of parts of cold water in which 1 part is soluble	No. of parts of hot water in which 1 part is soluble
Schlippe's salt (<i>see</i> Sodium sulphantimoniate)					Sodium nitrite	NaNO_2	69	1·4	—
Silver acetate	$\text{AgC}_2\text{H}_3\text{O}_2$	167	100 sol.	sl. sol.	" nitroprusside	$\text{Na}_2\text{Fe}(\text{CN})_5(\text{NO}) \cdot 2\text{H}_2\text{O}$	298	2·5	—
" ammonio-carbonate	$\text{Ag}_2\text{CO}_3 \cdot 2\text{NH}_3$	220	sol.	sol.	" oxalate	$\text{Na}_2\text{C}_2\text{O}_4$	134	33	—
" ammonio-nitrate	$\text{AgNO}_3 + 2\text{NH}_3$	229	v. sol.	v. sol.	" persulphate	$\text{Na}_2\text{S}_2\text{O}_8$	238	6·7	1
" bromide	AgBr	204	insol.	insol.	" phosphate	$\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$	358	3	v. sol.
" carbonate	Ag_2CO_3	276	insol.	insol.	" silicate	Na_2SiO_3	124	3	v. sol.
" chlorate	AgClO_3	101·5	20	—	" sulphantimoniate	$\text{Na}_2\text{Sb}_2\text{O}_7 \cdot \text{H}_2\text{O}$	479	3	v. sol.
" chloride	AgCl	143·5	insol.	insol.	" sulphate (cryst.)	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	322	3	v. sol.
" chromate	Ag_2CrO_4	332	insol.	—	" sulphide (dry)	$\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$	240	4	v. sol.
" citrate	$\text{Ag}_3\text{C}_6\text{H}_5\text{O}_7$	297	insol.	insol.	" sulphite (cryst.)	$\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$	226	2·2	—
" cyanide	AgCN	134	insol.	insol.	" tartrate	$\text{Na}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$	230	2·2	—
" fluoride	$\text{AgF}_4\text{H}_2\text{O}$	199	v. sol.	v. sol.	" tribasic phosphate	$\text{Na}_3\text{P}_2\text{O}_7 \cdot 12\text{H}_2\text{O}$	380	5·1	v. sol.
" iodide	AgI	235	insol.	insol.	" tungstate	$\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$	—	8 to 12	—
" lactate	$\text{AgC}_2\text{H}_3\text{O}_2 \cdot \text{H}_2\text{O}$	215	—	—	" vanadate	Na_3VO_4	184	sol.	—
" nitrate	AgNO_3	170	1	1	Starch (<i>see</i> Cellulose)		247·5	sol.	sol.
" nitrite...	AgNO_2	154	300	sl. sol.	Strontium bromide (dry)	$\text{SrBr}_2 \cdot 6\text{H}_2\text{O}$	355·5	1	·5
" oxalate	$\text{Ag}_2\text{C}_2\text{O}_4$	292	insol.	insol.	" bromide (cryst.)	SrBr_2	158·5	1·96	—
" oxide	Ag_2O	419	200	insol.	" chloride (dry)	$\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$	266·5	1·33	·6
" phosphate	Ag_3PO_4	312	insol.	—	" iodide (cryst.)	$\text{SrI}_2 \cdot 6\text{H}_2\text{O}$	449	·56	·25
" sulphate	Ag_2SO_4	248	v. sol.	v. sol.	Sugar of lead (<i>see</i> Lead acetate)				
" sulphide	Ag_2S	166	—	—	Tannin (<i>see</i> Acid, digallic)				
" sulphocyanide	AgSCN	166	—	—	Thiocarbamide		76	11	v. sol.
" tartrate	$\text{Ag}_2\text{C}_4\text{H}_4\text{O}_6$	364	sl. sol.	—	Thiosinamide		116	17	—
Soda, caustic (<i>see</i> Sodium hydrate)	$\text{NaC}_2\text{H}_3\text{O}_2 \cdot 3\text{H}_2\text{O}$	136	1	v. sol.	Thymol		150	330	v. sol.
Sodium acetate	$\text{NaC}_2\text{H}_3\text{O}_2$	82	—	—	Tin (stannous) chloride	$\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$	225	1·5	—
" acetate fused					Uranin		376	sol.	—
" bicarbonate (borax; <i>see</i> borate)					Uranium acetate		426	v. sol.	v. sol.
" bicarbonate	NaHCO_3	84	11·3	dec.	" chloride		361	v. sol.	v. sol.
" bicromate...	$\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$	298	1	·6	" nitrate		504	·5	·25
" bisulphite	NaHSO_3	104	3·5	—	Vanadium chloride		422	v. sol.	v. sol.
" borate	$\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$	382	17	·5	Verdigris (<i>see</i> Copper acetate)		—	—	—
" bromide	NaBr	103	1·1	·9	Vitriol, blue (<i>see</i> Copper sulphate)		18	—	—
" carbonate (dry)	Na_2CO_3	106	6	2·2	" green (<i>see</i> Ferrous sulphate)				
" carbonate (cryst.)	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	286	1·6	v. sol.	" white (<i>see</i> Zinc sulphate)				
" chloride	NaCl	58·5	2·7	2·5	Water ...				
" chloroplumbite	$\text{PbCl}_2 \cdot 2\text{NaCl} \cdot \text{H}_2\text{O}$	500·4	sol.	—	Washing soda (<i>see</i> Sodium carbonate)				
" citrate	$\text{NaC}_6\text{H}_5\text{O}_7 \cdot 11\text{H}_2\text{O}$	714	1·1	—	Wood alcohol (<i>see</i> Alcohol methyl)				
" fluoride	NaF	42	23	—	Zinc bromide		225	·3	v. sol.
" formate	$\text{NaCHO}_2 \cdot \text{H}_2\text{O}$	86	—	—	" chloride		136	·3	v. sol.
" hydrate (caustic)	NaOH	40	1·62	v. sol.	" iodide		319	·3	dec.
" hydrosulphite	$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	248	·65	v. sol.	" sulphate (white vitriol)		287	·62	v. sol.
" iodide	NaI	150	·5	·4					
" nitrate	NaNO_3	85	1·1	·6					

water than is required for the working strength, and adding water at the time of use. Take any one solution "ready-for-use" formula. Assume that it includes 10 oz. of water. To prepare a concentrated solution, use only 5 oz. of water, when, of course, a bottle half the size can be utilised. When required for use dilute with an equal bulk of water.

SOLUTIONS, MAKING UP

The method of making up photographic solutions should not be a haphazard one. The salts, in making up a stock solution, for example, must not be all placed in a dry bottle and the water added, for this conduces to slow and often incomplete solution. Another important point is the quantity of water used. In the majority of the formulæ given in this work the quantity of solvent is, where possible, given so as to make a total bulk of either 10 or 20 oz., or 1,000 ccs. Take any formula, such, for instance, as a developer containing—

Pyro	1 oz.	50 g.
Sodium sulphite	4 "	220 "
Citric acid	1 "	55 "
Distilled water to	20 "	1,000 ccs.

If the solids were weighed out and 20 oz. or 1,000 ccs. of water added, the total bulk would be more than 20 oz. or 1,000 ccs., and unless the total bulk were measured it would be impossible to determine the exact quantity of solution to use for a given weight of pyro. The correct method is to dissolve the solids in about three-fourths of the total bulk of water, and then add sufficient water to make the given quantity. Again, in making developers, it is advisable to dissolve the preservative, the sulphite or metabisulphite, first and then add the developing agent, except in the case of metol, which should always be dissolved first. When there are several salts given, it is usual in photographic formulæ to dissolve them in the order in which they are given, and it is preferable always to use warm or hot water and dissolve each salt separately. In nearly all cases there is considerable lowering of the temperature when salts are dissolved, hence the value of hot water, for most salts are more soluble in hot than in cold water. As all solutions are of greater specific gravity or heavier than the solvents, it is not a good plan to place the salts in a bottle, fill up with water, and allow to stand, as the bottom of the liquid becomes a saturated solution, whilst the top may be nearly pure water. An excellent method is to use linen or muslin bags containing the salts and suspend them from the top of the bottle or jug, when the solution of the salts rapidly sinks to the bottom, its place being taken by fresh water or weaker solution; this method has the advantage, too, of straining out any dirt or foreign matter from the solution.

The precautions given under the heading "Water" should also be noted.

In a 10 per cent. solution, 10 parts by measure contain one part of the dissolved substance. The rough-and-ready method of mixing together 1 oz. of the salt and 9 oz. of water does not make a true 10 per cent. solution. Ten fluid ounces contain 4,800 minims, and should therefore contain 480 grs. of the salt. Chemicals are

always sold by avoirdupois weight, 1 oz. of which contains 437½ grs., the apothecaries' ounce consisting of 480 grs. The former and lighter ounce therefore needs less water than the latter in order to make a true 10 per cent. solution; but, happily, the difference is not so much as to make a very great difference in the working powers of solutions. The correct way to make a 10 per cent. solution is to place the 1 oz. (avoirdupois, as bought) of chemical in a measure or bottle, and make up to a total bulk with water, of 9 oz. 55 mins. (9 oz. 1 drm. is near enough). Ten mins. of such a solution will contain 1 gr. of the dissolved chemical.

Solutions are not always made up in the 10 per cent. strength. When the proportion in a formula is given as a percentage, the number of grains of solid per ounce of liquid can be obtained by multiplying the percentage figure by 4 and adding to the result its tenth part. Thus 5 per cent. = $5 \times 4 = 20$; $\frac{1}{10} \times 20 = 2$; $20 + 2 = 22$; that is, 5 per cent. = 22 grs. per ounce (approx.).

The table given below shows the exact composition of "per centage" and "part" solutions:—

Strength of Solution	For each ounce of water take of the salt	Strength of Solution	For each ounce of water take of the salt
	Grs.		Grs.
1 per cent.	4.375	1 in 1,000	4375
2 per cent.	8.75	1 in 500	875
3 per cent.	13.125	1 in 400	10937
4 per cent.	17.5	1 in 300	14583
5 per cent.	21.875	1 in 200	21875
10 per cent.	43.75	1 in 100	4375
15 per cent.	65.625	1 in 50	875
20 per cent.	87.5	1 in 25	175
25 per cent.	109.375	1 in 10	4375
40 per cent.	175	1 in 5	875

SOLUTIONS, SATURATED (See "Saturated Solution.")

SOLUTIONS, STOCK (See "Solutions, Making up.")

SOLUTIONS, SUPER-SATURATED (See "Super-saturated Solutions.")

SOLUTIONS, TEMPERATURE OF (See "Temperatures.")

SPANISH COMBINED BATH

A combined toning and fixing bath for gelatino-chloride paper, said to have been invented by a Spanish expert, but closely resembling other combined baths. It gives rich tones on prints from good negatives, and the formula, as generally published, is as follows:—

"Hypo"	2½ oz.	300 g.
Am. sulphocyanide	75 grs.	19 "
Sub. acetate of lead	50 "	12.5 "
Nitrate of lead	15 "	3.75 "
Citric acid	15 "	3.75 "
Alum	50 "	12.5 "
Water	9 oz.	1,000 ccs.

Dissolve in hot water, stand a few days, filter, and add :—

Gold chloride . . .	5 grs.	1.25 g.
Water	1 oz.	110 ccs.

SPECIFIC GRAVITY (Fr., *Pesanteur spécifique*, *Densité*; Ger., *Spezifisches Gewicht*)

Synonym, density. The weight of a certain bulk of a solid or liquid compared with that of the same bulk of water; in the case of gases, hydrogen is the standard. Thus, a certain measure of water is found to have a weight of 3 lb.; the same measure of mercury is found to

have a weight of 40.8 lb; then $\frac{40.8}{3} = 13.6$, which is the specific gravity of mercury. Densities of solutions are commonly measured with the hydrometer (*which see*), there being, as a rule, a relation between specific gravities and hydrometer degrees.

SPECTACLE LENSES

Simple lenses consisting of only one piece of glass, and occasionally used in photography. Owing to their being non-achromatic, their chemical and visual foci do not coincide, and, after focusing, the distance between lens and plate is decreased by $\frac{1}{10}$ to $\frac{1}{6}$ of an inch when photographing normal objects; in portraiture, copying, etc., the correction needs to be greater.

SPECTACLES, MONOCHROMATIC

Spectacles or monacles, usually of blue glass, used for judging the appearance of the view to be photographed. Seen through blue glass, the colours in the view are toned down or obliterated, and one gets a better idea of how the picture will be represented in the monochrome print. A blue focusing (ground-glass) screen gives the same effect. (*See also* "Stereoscopic Spectacles.")

SPECTROGRAPHY (Fr., *Spectrophotographie*; Ger., *Spektrophotographie*)

Any spectroscope may be converted into a spectrograph or camera for photographing the spectrum by attaching to the telescope a camera instead of an eyepiece. The simplest form is that in which a direct-vision spectroscope is used, and it may be either an ordinary camera or merely an oblong box to the front of which the spectroscope is attached, whilst the back carries the dark-slide for the plate. The usual eyepiece lens must be removed, and care should be taken that no part of the mount cuts off the spectrum. No lens need be used, and the length of the spectrum is then solely dependent on the extension of the camera. If a lens is used, then the lines will be sharper. A shows the simple box form without lens; F is the box, D the direct-vision prism, B the slit, A the condenser, and K the milled head for focusing the collimator lens. B shows the form with lens D behind the prisms; H is an outer tube that prevents stray light having access to the camera, K is the groove for the dark-slide, and R a central screw, on which the back can be swung to any angle and then fixed by the screw F; b is a short length of bellows.

When using the direct-vision spectroscope, the line that passes straight through is generally

the D line; therefore the spectroscope must be placed above the centre of the plate, otherwise the violet end will not be included. With the spectrograph without lens, the length and width of the spectrum are dependent solely on the extension of the camera.

In the ordinary single or two-prism spectroscope the telescope should be entirely replaced by a light camera, and it is advisable to cover over the prism table and the lenses so that no light has access to the plate but through the slit; otherwise general fogging of the plate will ensue.

It is convenient to take a series of negatives on one plate, and this can be done by small sliding shutters in front of the slit, but more conveniently by providing a slit, say, of one inch width, in the back of the camera and arranging for the dark-slide to be shifted in its grooves so that three or four contiguous spectra may be obtained by merely shifting the plate. With all prismatic spectrographs it is essential to arrange for the swinging of the plane of the plate; that is, for putting the violet end nearer the lens than the red. If the spectroscope is always to be used with the same prisms and lenses, then this can be done once for all; otherwise slots and screws must be provided as shown in diagram B.

One great disadvantage of the prismatic spectrograph is the uneven dispersion, the red being cramped together and the blue and violet more extended. On the other hand, this may be an advantage in photographing very faint absorptions or sensitising action in the red if mere qualitative and not quantitative results are desired. This unequal dispersion is well shown in C and D; the former represents the spectrum produced by a diffraction grating and the latter a spectrum of equal length and dispersion produced by a prism.

With all glass there is more or less absorption of the ultra-violet, and with heavy flint glasses with great dispersion this may even extend into the visible violet. Quartz, calcite, and fluorite are very transparent to this region, and must be used both for prisms and lenses if photography of the ultra-violet is to be attempted. Undoubtedly the concave grating which requires no lens is most useful for this region. Practically, ordinary glass may be considered not to transmit beyond λ 3,400 when a thickness of about $\frac{1}{4}$ in. is used. Another disadvantage with the prismatic spectrograph is that the lines are curved with the convex side towards the red, due to the fact that only those rays which pass through the centre of the slit can pass through a plane perpendicular to the refracting edge of the prism, which is usually called the principal plane.

Diffraction-grating spectrographs are far more satisfactory for all photographic work, especially now that the excellent celluloid replicas can be obtained so cheaply. The principle of the direct-vision spectroscope is described elsewhere, and the same arrangement may be used for the spectrograph. A section of such an instrument, designed by Tallent, is shown at E, in which S is the slit, C the collimator lens, D the grating cemented to a narrow angle prism which refracts the central white beam to W into a small

pocket of blackened wood; *I*, is the camera lens, and *P* the dark-slide. The lenses are single landscape lenses, and their foci or that of the camera lens will depend upon the length of the spectrum desired. A lens of $14\frac{1}{2}$ in. will give a spectrum of about 4 in. in length between λ 3,500 and λ 8,000. The slit must be placed at the equivalent focus of the collimator lens, and all parts except just the grating aperture should be blocked out and the interior of the camera lined with black velvet or blackened to prevent reflections.

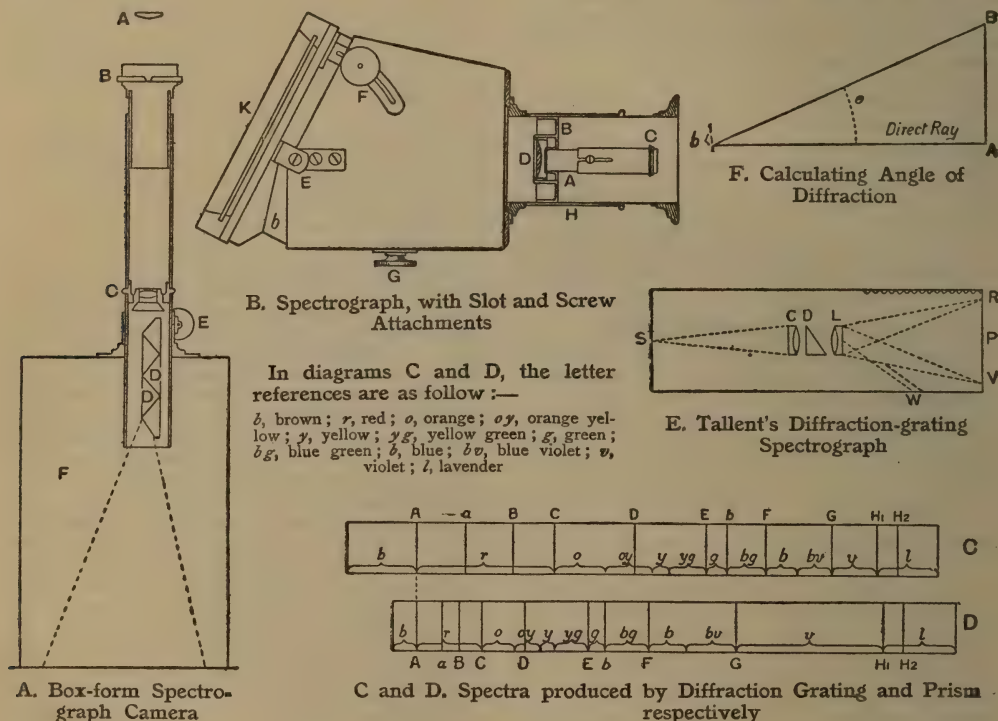
If it is not desired to use a prism grating, then obviously the plate must not be in a straight line with the grating, but at the angle of diffraction. This may be calculated as follows: The

$$1 \text{ inch} = \frac{1}{.03937043}$$

$$\therefore b = \frac{1}{.03937043 \times 14490} \text{ mm.}$$

$$\therefore b = .00175292$$

The correct position of the plate may also be found by supporting the collimator lens on a block of wood, or temporarily attaching it to a card and placing the slit at its equivalent focus close to a strong light; then, on inserting the grating close behind the lens, the first order spectrum will be seen on each side of the white image of the slit, and the distance from this will, of course, give the angle between the axial line and the grating. The grating may be placed at



spectra formed by a diffraction grating lie on each side of the central white image, and to find the distance of the first wave-length or the angle of diffraction let *F* represent a spectroscope in which *b* is the grating space—that is, the width of one ruling and the adjacent space—and *e* the angle of deviation. What we wish to determine is either *e*, or the length of *AB*, then taking .0003340 mm. as the first wave-length which it is desired to find the position of—

$$AB = \sin e = .0003340 \div b$$

and assuming that *b* = .001752, we have—

$$\sin e = .0003340 \div .001752 = .1906 = 11^\circ \text{ practically.}$$

The grating space, or *b*, is found very easily, thus: Assuming that we have a grating with 14,490 lines to the inch, then—

right angles to the collimator lens, or preferably so that its plane cuts the angle between the axes of the collimator and camera lens—that is, so that the angles of incidence and diffraction are equal.

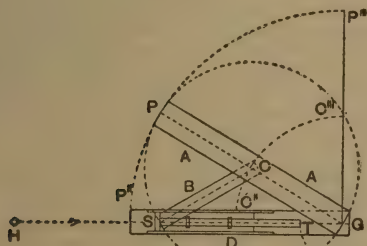
For a plane metal or reflection grating the arrangement shown for this (see "Spectroscope") may be adopted, replacing the telescope by a camera, and fixing the collimator and camera at an angle of 45° , the grating being mounted on a revolving table.

Excellent replicas, cemented to sections of convex lenses so as to form concave gratings, being now obtainable, it may be as well to give Eder's method for mounting concave gratings for spectrography. The idea is to keep the slit position constant, which is a great convenience when using a heliostat or fixed source of artificial light, *H* in *G*. The camera moves round a

point G; the slit S, which is joined to the tube T, always moves along SG; the plate P moves on the arc P''P''' which is struck from the centre G; the slit S is joined by a rod SBC to C, which is the centre of the distance PG, G being the grating. It is obvious then that as the plate is moved round the arc P''P''' the slit and the grating also move. The central point of the grating must be exactly over the point G, and the slit S must be exactly over the point S, at which the rod is joined to T. T is a collapsible tube, which can be shortened or lengthened as it approaches or recedes along SG.

When diffraction spectra are used, the spectra are not isolated, but overlap; and this overlapping follows the law $\lambda^1 = 2\lambda^2 = 3\lambda^3 = 4\lambda^4 = 5\lambda^5$, in which $\lambda^1, \lambda^2, \lambda^3$, etc., are the wave-lengths in the first, second, third, etc., orders. This overlap is shown in the following table, taking λ 6,000 in the first order:—

First order spectrum	6,000		
Second "		3,000	6,000
Third "		1,500	4,000 6,000
Fourth "			3,000 4,500 6,000
Fifth "			3,600 4,800
Sixth "			3,000 4,000



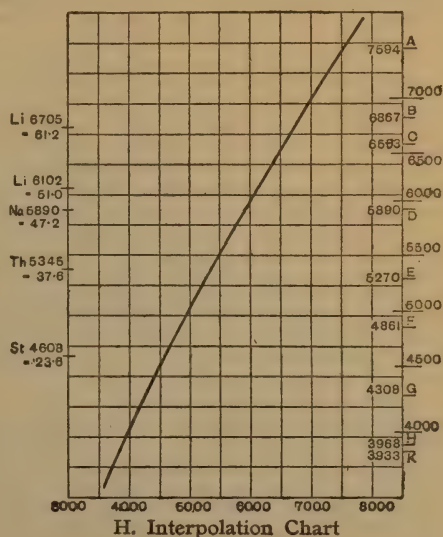
G. Use of Heliostat in Spectrography

For visual work this overlap is of no moment when using the first order only, because the eye is not sensitive to the ultra-violet; but in spectrography this overlapping may be very troublesome, particularly when dealing with the extreme red, for if we take the limit set by the absorption of the glass as λ 3,400, as that which would act on the plate, this line would coincide with λ 6,800 in the first order, and therefore the farther we proceed with the red the more active will be the ultra-violet of the second order, and thus totally erroneous conclusions may be drawn from the results.

This superposition of the second order can always be seen in negatives when using daylight, the electric arc, or magnesium ribbon; so that it is as well to use some absorbent material between the light source and the plate. This may be either in front of the slit or, preferably, in front of the plate itself. In the former position there may be used a cell containing a solution of aesculin or filter yellow K, or a gelatine screen stained with the above. For a screen in contact with the plate it is advisable to coat a sheet of thin patent plate with a 5 per cent. solution of gelatine, and when dry to stain up about half of the plate; that is, up to about where the D lines fall, with filter yellow K or dianil orange G. The screen should then

be placed in contact with a plate and a long exposure given to the arc or magnesium ribbon to see that it does absorb the whole of the ultra-violet.

It may also be found convenient to fix permanently in the dark-slide a scale either of wave-



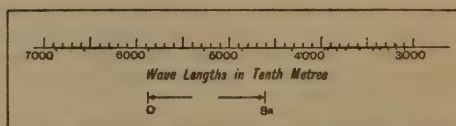
H. Interpolation Chart

lengths or one merely divided into known divisions, and excellent glass scales 10 mm. in length and divided into millimetres can be obtained commercially. With such a scale, which is impressed on the plate at each exposure, it is easy to calculate with approximate accuracy the wave-length of any line or the limits of an absorption band, etc. For instance, having determined that the distance between H₁ and C is exactly 90 mm., we have only to divide $d\lambda$ —that is, their difference in wave-length—by 90 to find the number of wave-lengths to a millimetre, thus—

$$\begin{aligned} C\lambda 6563 - H\lambda 3968 &= 2595 \\ \therefore 2595 \div 90 &= 28.8 \text{ wave-lengths per millimetre,} \\ \text{so that if an unknown line was found } 10.5 \text{ mm.} \\ \text{from H, its approximate wave-length would be} \\ 3968 + (28.8 \times 10.5) &= 4270.4. \end{aligned}$$

Obviously, this method is but approximate, but it is useful when studying absorption spectra or the sensitiveness of a plate.

To construct a wave-length scale, the easiest method is that suggested by A. J. Newton



I. Wave-length Scale.

(Penrose's *Pictorial Annual*, 1905-6, p. 81), but it requires an arc lamp, though the lines may be obtained by the method described under the heading "Wave-lengths." Narrow the slit down so that the D lines are divided; then, using

a panchromatic plate, photograph the lithium sodium, thallium, and blue strontium line. A sheet of plain glass should be placed in the dark-slide to represent the scale plate which will subsequently be fixed there. For the lithium lines use a deep red screen in front of the slit and give about two minutes' exposure; then with a yellow or green screen obtain the thallium line, and finally the blue strontium line without a screen.

After development, measure accurately the distance between the lines and make an interpolation chart with the wave-lengths as abscissae (see H) and the distance of the lines as ordinates, and draw the curve or straight line. It is advisable to increase the actual distances by some unit, say 10, all through. Then mark the wave-lengths in whole numbers, starting at λ 3,500 and going up to λ 7,500 or higher. The result will be as shown in H. From this draw an enlarged diagram, with the distances marked as at I, and then copy this in an ordinary camera down to the required size. From this negative make a positive by contact, and cement it into the dark-slide so that the D lines coincide exactly with those marked on the scale.

In photographing the spectrum for any purpose whatever, one must take into account the various factors incident to each region. For the ultra-violet, as has been pointed out, we must discard glass or use a concave grating. For the infra-red, glass is transparent enough probably for as far as the beginner is likely to want it. For the ultra-violet and the visible spectrum up to about λ 5,000 any ordinary plate may be used; but it is in dealing with the other half of the spectrum up to about λ 7,000 that one has to use special colour-sensitive plates. For green and blue-green, acridine orange NO is the best sensitiser, though this region may be well recorded on any commercial erythrosine or isochromatic plate provided a long exposure be given or absorbing screen used. The erythrosine plate will also record to about λ 6,000, but beyond this one must use a panchromatic plate, sensitised with orthochrome T, pinaverdol, pinachrome, or homocool. For the extreme red—that is, from about λ 6,400 to λ 6,800—pinacyanol is the best dye; whilst for λ 7,000 to λ 7,200 dicyanine is the most satisfactory. The method of preparing these plates is described elsewhere.

The plates must have a black backing. As regards the exposure but little help can be given, and in developing care should be taken not to prolong the duration too much, as otherwise fine faint lines may be easily buried.

SPECTROMETER (Fr., *Spectromètre*; Ger., *Spektrometer*)

A spectroscope in which the prism or grating is mounted on a table, which is graduated into degrees and minutes so that the deviation of any line may be read.

SPECTRO-PHOTOGRAPHY (See "Spectro-photography.")

SPECTRO-PHOTOMETER (Fr., *Spectrophotomètre*; Ger., *Spektrophotometer*)

An instrument by means of which the luminosity of various regions of two spectra can be

directly compared. Various forms have been suggested.

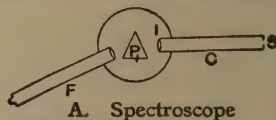
There is, first, the double-slit photometer of Vierorot, in which the lights to be compared fall on the slit, the two halves of which can be opened or closed, and thence passed through a prism, to appear at the eyepiece as adjacent spectra; they are compared by opening and closing the one slit which transmits the light to be measured, whilst that transmitting the standard light is kept constant. The eyepiece of the telescope is provided with sliding shutters which enable one to limit the field of view to the particular region under examination. The disadvantage of this method is that the two spectra are not of equal purity, and therefore not of the same colour, this being an inherent defect in the use of two slits of different widths.

Lummer and Brodhun introduced a photometer with two collimators at right angles to one another, the lights being brought into juxtaposition by means of a Lummer-Brodhun rhomb and thence dispersed. The reduction of one of the lights is produced by rotating sectors.

Polarising photometers have been devised by Glan, Crova, Hüfner, König, Glazebrook, etc. Their principle is that the lights are received through two contiguous slits, then pass through the dispersing medium, a Wollaston prism, and are brought into juxtaposition by a biprism, thence reaching the eyepiece, which is fitted with an analyser. This method also has its faults, and is really only strictly correct when monochromatic spectrum rays are used.

SPECTROSCOPE (Fr., *Spectroscope*; Ger., *Spektroskop*)

An instrument designed for seeing a spectrum and consisting essentially of three parts—the slit, the dispersing medium, and the observing telescope. The latter is essential if it is desired to see the spectrum uncontaminated by white light, though it is possible to see a spectrum in any ordinary room with no more apparatus than an opaque card with a slit in it and the dispersing medium. If, for instance, a slit about 1 in. long and $\frac{1}{4}$ in. wide is cut in an opaque card about 12 in. long and 6 in. wide, and this card is placed



on the cross-bar of a window, a fairly pure spectrum can be seen by going to the other side of the room and examining the slit through the dispersing medium held close to the eye. A complete spectroscope is shown at A, in which C is the collimator, consisting of a slit S at the focus of the lens I; P is the prism, or dispersing medium; and F the telescope which receives the refracted and dispersed beam. A third telescope is sometimes provided which throws a numbered scale on to the second face of the prism, whence it is reflected to the telescope and the eyepiece.

The slit is usually made of metal, and consists of two plates, one of which may be fixed and the other movable, the latter being actuated

by a micrometer screw so that its distance from the fixed jaw may be varied at will. In purchasing a slit, stipulation should be made that the jaws are of platinoid, a hard white alloy which does not readily tarnish. It is advisable also to have what is known as a symmetrical slit—that is, one in which both jaws are moved simultaneously by one screw. For very accurate wave-length determination this is important, as it is the centre of the line which is measured, and with a symmetrical slit this is constant, whereas with an unsymmetrical slit the spectral line widens on one side. On the other hand, it is quite possible to obtain wave-length readings, of sufficient accuracy for all ordinary work, with a slit having only one movable jaw if the edge of the spectrum line that coincides with the fixed jaw is taken for measurement. It is necessary that the jaws of the slit be bevelled with the bevel inside, and that the bevel be blackened, as this prevents reflection of the light. The jaws must be parallel and without any side slip, and parallelism of the jaws can be easily tested by opening the slit, then gradually closing it down till the aperture entirely disappears. This it should do throughout its entire length simultaneously. The edges of the jaws are easily damaged, and therefore the slit should never be screwed up roughly or too tightly. As the slit for normal work is extremely narrow, dust particles are very apt to lodge between them and give rise to dust lines, which are longitudinal black lines running throughout the length of the spectrum. These dust lines, whilst detracting from the appearance of the spectrum, are convenient in one way, as they prove whether the slit is parallel to the edge of the prism or the ruling of the grating, as if parallelism exists the lines are parallel to the edges of the spectrum. To clean a slit from dust particles a soft wood match stick should be cut to a fine bevel or chisel shape, and, the jaws being opened, the match should be inserted and the jaws closed till just gripping the wood, and then the match should be moved up and down and the jaws again opened and the match removed. When chemicals or solutions are burnt or volatilised by a spark close to the slit, it is apt to get splashed with particles of the salt; it is advisable then to use a condenser, which enables the spark to be worked some distance from the slit and focuses the image on the slit, or a thin microscopic cover glass may be temporarily placed in front of the slit.

Frequently a slit is provided with draw plates which cover parts of the slit, thus enabling two or more contiguous spectra to be photographed.

The dimensions of the slit depend upon the aperture of the collimator lens and the prism or grating, and it may be taken as a safe rule that the clear aperture of the slit should not be less than one-third the diameter of the lens. To some slits is also fitted a piece of metal with a wedge-shaped aperture cut in it; this is used to limit the size of the spectrum, and is an advantage for spectrography, as it enables one to narrow the width of the spectrum and thus prevents the diffusion of stray light. In most spectroscopes the aperture of the slit is narrowed by an internal diaphragm, which prevents scat-

tered light reaching the collimator lens. It is usual, too, for the slit to be mounted on a focusing tube, but for spectrography it is just as well to determine once for all the accurate distance of the slit from the collimator lens, and fix it so; and this does not at all interfere with the use of the instrument for visual work. The focal length of the collimator lens is merely a question of convenience, though naturally there are certain theoretical considerations that govern this. The rays from the slit are parallelised by the collimator lens, and we may calculate the breadth of the slit image as formed by the telescope or camera lens thus: let s = the height or length of the slit, f = the focus of the collimator lens, F = the focus of the telescope or camera lens, and S = the image formed by the latter, then—

$$S = s \times \frac{F}{f}$$

For instance, suppose the length of the slit = 12 mm., the collimator lens focus = 250 mm., and the camera lens focus = 500 mm., then—

$$S = 12 \times \frac{500}{250} = 24 \text{ mm.}$$

which will be the breadth of the slit image or spectrum.

It is essential that the collimator lens be achromatic, and that the slit be exactly at its equivalent focus. If these two points be not attended to, the aberrations of the lens come into play, and critical sharpness of the spectrum lines is impossible. The method of adjusting the slit and collimator for visual work is very simple. Assuming that the telescope eyepiece is fitted with cross wires or spider lines, these should be sharply focused and then the telescope focused for a very distant object, such as a church spire or tree. Then, without altering the telescope focus, swing it into line with the collimator lens, removing the dispersing medium, and obtain a sharp image of the slit by racking it nearer to or from the collimator lens. It is important, too, that the slit should be central with the axes of the collimator and telescope lenses. This can be determined by placing an opaque card with a small central hole over the slit and seeing whether the image of this hole falls in the centre of the collimator lens and the eyepiece.

The prism usually supplied with spectroscopes has a refracting angle of 60° , and it is important that it should be level and with the refracting edge parallel with the slit. Should the slit not be parallel with the refracting edge, it will be found that the Fraunhofer lines are not exactly at right angles to the length of the spectrum. As a rule, it will be found that the slit tube can be revolved so that this fault can be easily remedied. Should the spectrum not entirely fill the eyepiece—that is to say, if the height of the slit be reduced so that the spectrum is seen only as a narrow stripe across the field of view—the non-parallelism of the slit and prism edge can also be seen by the width of the spectrum decreasing or increasing as the slit is turned one way or the other.

The dimensions of the prisms should be such that they will entirely take up the beam of parallel light from the collimator. The height must therefore be equal to the diameter of the

collimator lens, but the length must be greater. This can be shown mathematically to be:

$$l = \frac{h}{\sqrt{1 - \mu^2 \sin^2 \frac{A}{2}}}$$

calling l = the length, h = the height, and μ = the index of refraction, then for a 60° prism and



B. Direct-vision Spectroscope

an index of refraction of 1.5 and a height of 2 in. this becomes:

$$l = \frac{h}{\sqrt{1 - \frac{\mu^2}{4}}} = \frac{2}{\sqrt{1 - \frac{1.5^2}{4}}} = 3.02 \text{ in.}$$

The telescope should, like the collimator, have an achromatic lens, and should be of the same dimensions, and is generally of the same focus. The eyepiece is usually that known as a Ramsden, in which two plano-convex lenses are placed with their convex surfaces towards one another, the distance between them being about two-thirds of the focal length of one of them. This is frequently provided with cross wires or spider lines, which are used for measuring the position of a line. There are many different forms of eyepieces, some being provided with a bright metallic point, on to which the light is reflected from the outside by a small mirror. In others, such as the Gauss, a line of light is reflected by a piece of silvered glass. Micrometer eyepieces are also sometimes used, in which a micrometer screw moves a plate or wire across the spectrum, the amount of travel being read off on a divided drumhead or scale. These eyepieces are used for the measurement of wave-lengths, but visual measurement has been almost entirely superseded by the spectrographic method.

A very convenient accessory to the eyepiece is two sliding shutters, which can be pushed in from either side, thus enabling one to limit the field of view and cut out a brilliant line which might otherwise overpower a close, faint one. There are two other accessories often fitted, but which, except for rough visual measurement, are of little practical value. The first is the comparison prism, which is a small reflection prism that can be swung over half the slit, the advantage being that one can compare two light



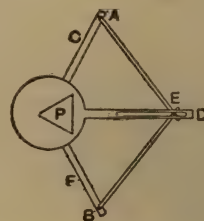
C. and D. Three-prism and Five-prism Trains for Spectroscope

sources, for instance daylight, which may be admitted to the slit in a straight line, and a vacuum tube or cell filled with coloured fluid, which can be placed at right angles to the axis of the collimator. The other accessory is a scale of lines, which is projected from the last face of the prism into the eyepiece.

For rough visual work it is usual to employ direct-vision spectroscopes, and these are fitted

with three or five prisms placed base to apex, the glass being so chosen that whereas the deviation of the D line, for instance, by the one set of prisms is counteracted by the others, so that it emerges in a straight line, the other colours are spread out on either side of it. The usual form of the direct-vision spectroscope is shown at B, in which S is the slit, B the collimator lens, P the train of prisms. The distance between the slit and collimator lens is adjustable by sliding the whole tube A out. Frequently a lens is placed at the aperture E for an eyepiece. An extra fitting, C, carrying at one end a condensing lens, L, which can be focused on to the slit by sliding the tube, is a great advantage, as it limits the light received by the slit to that which it is desired to examine. Occasionally a comparison prism and photographed number scale are also fitted. C and D show respectively three-prism and five-prism trains.

For the critical examination of a spectrum it is advisable that the line or region under examination should pass through the prism at the angle of minimum deviation. Unless a special form, or, as it is usually called, an auto-collimating



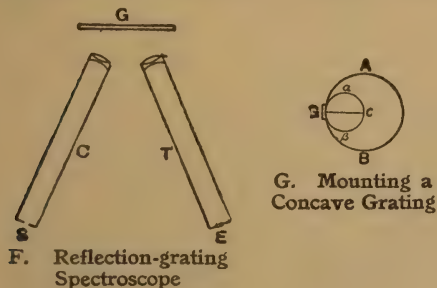
E. Auto-collimating Spectroscope

spectroscope, be used, it would be necessary to adjust the prism for this position for every line. Several such instruments can be obtained commercially, but a simple form, which is not difficult to fit to any spectroscope, is shown at E. To the prism table is fastened a slotted brass rod, D, a continuation of which just bisects the refracting angle of the prism P, when this is placed at the angle of minimum deviation for the D line. C is the collimator and F the telescope, and to their ends are fastened two thin brass rods, A E and B E, which, when the position of minimum deviation is found, are joined together by a pin, E. Then any movement of the telescope also moves the collimator and prism into the position of minimum deviation.

A spectroscope fitted with a diffraction grating is much to be preferred for most purposes, because the spectrum is normal; that is to say, the distances apart of the rays of different colours are arranged according to their wave-length. On the other hand, as the prismatic spectrum is more brilliant, the prism is to be preferred for very faint spectra.

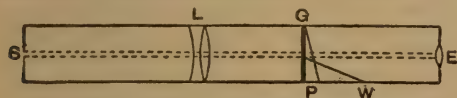
All the parts of the details given above for the prismatic spectroscope apply to that made with a diffraction grating or replica, and the same precautions have to be observed to ensure parallelism between the slit and the rulings of the grating, and the plan (see E) may be taken as the plan of a diffraction-grating spectroscope if the prism be removed and replaced by a transmission grating.

With a plain reflection grating it is obvious that we cannot see through the metal, but we see the spectrum reflected from its surface, so that, although we may use the same stand, the collimator and telescope are arranged as at F,



in which *c* is the collimator, *s* the slit, *t* the telescope, *e* the eyepiece, and *G* the grating.

Direct-vision grating spectroscopes are also made, but in this case (as at H) the grating *G* is cemented to a prism *P* of narrow angle, which throws the central white beam *w* out of the field of view. *s* is the slit, *l* the lens, and *e* the eyepiece. For all advanced work the concave grating is most generally used, and it has the great advantage that no lenses are required, for the metal, being cast and polished to a spherical form, acts like a concave mirror and forms an image without the aid of lenses. The particular method of mounting concave gratings is rather beyond the scope of this work, but the principles involved may be given. In diagram G, let *AB* be a circle struck from the centre *c*; *G* is the grating. It is obvious that *G* is an arc of the circle of which *cG* is the radius. Now it was proved by Rowland that if a light source—which is, of course, the slit—and the grating be placed on the circumference of a circle *Gacβ*,



H. Direct-vision Grating Spectroscope

which has as diameter the radius of curvature of the grating, then the image of the slit would also be formed on this circumference. Therefore it would only be necessary to place an eyepiece at the point where the image is formed to see the spectrum.

SPECTRUM (Fr., *Spectre*; Ger., *Spektrum*)

A ribbon or band of colours formed when a narrow beam of heterogeneous light traverses a dispersing medium such as a prism or diffraction grating.

SPECTRUM ANALYSIS (Fr., *Analyse spectrale*; Ger., *Spektral-analyse*)

The analysis of a substance by burning or otherwise raising it to the point of incandescence, as, for instance, by the electric current, and then examining the light by a spectrocope. As all substances give characteristic spectra, with bright lines always of the same wave-length, it is possible to tell what substances are burning

or incandescent. Spectrum analysis is only qualitative and not quantitative; that is to say, the elements present can be named, but the quantities in which they exist in the substance under examination cannot be stated.

SPECTRUM CURVE (Fr., *Courbe spectrale*; Ger., *Spektrum-Krümmung*)

The curve obtained by photographing the spectrum on a sensitive surface, which, by the deposit of metallic silver or alteration of colour, indicates the colours to which the substance used is sensitive.

SPECTRUM HELIOGRAPH (See "Helio-graph.")

SPECTRUM, LUMINOSITY OF

The first examination of a spectrum at once shows to the veriest tyro that the luminosity of the colours varies enormously. The following table gives the generally accepted distribution of the colours and the visual luminosity of the various regions of the solar spectrum.

Colour	Wave Length λ		Luminosity	Quantity of light, the total being = 1,000
	Of the colour μ	Of the limits of the colour		
Red . .	663	625	8	91
Orange . .	610	600	76	147
Yellow and Yellow-green }	575	550	100	396
Green and Blue-green }	526	490	64	303
Bright blue } and Indigo }	472	450	12	38
Blue-violet .	440	430	7	13
Violet . .	420		4	12

Note that the above table applies only to the solar spectrum as regards the last two columns, and that the figures in these would differ for almost every light source.

SPECTRUM, PHOTOGRAPHING THE (See "Spectrography.")

SPECTRUM, SOLAR (Fr., *Spectre solaire*; Ger., *Sonnenspektrum*)

The spectrum given by direct or reflected sunlight. As has been pointed out (see "Fraunhofer Lines"), the solar spectrum is crossed by numerous dark lines of greater or less breadth and intensity, and the discovery of the actual cause of these lines is ascribed to Kirschhoff in 1859. He enunciated three laws, which practically explain the formation of all spectra: he said (a) that a substance when excited by some means tends to emit definite rays, the length of the wave depending upon the substance and its temperature; (b) a substance also exerts a definite absorption, which is a maximum for the rays it emits; (c) the ratio between the emissive and absorptive power is constant for all

substances at the same temperature. The first two laws explain the occurrence of the Fraunhofer lines in the solar spectrum.

SPECTRUM, VIRTUAL (Fr., *Spectre virtuel*; Ger., *Virtuell Spektrum*)

A term applied to any spectrum seen through a prism or grating, and which is not formed by the aid of lenses.

SPEED INDICATOR (Fr. *Indicateur de vitesse*; Ger., *Geschwindigkeitsmesser*)

An appliance patented by the Thornton-Pickard Company for use with their roller-blind shutters. It consists of a dial marked with the different speeds, and having a pointer so geared as to move in accordance with the tension of the spring blind. The indicator shows at a glance the speed at which the shutter is set.

SPEEDS, PLATE (See "Sensitometry.")

SPERM CANDLE (See "Sensitometry," sub-heading "The Standard Light.")

SPHERICAL ABERRATION

The failure of a lens having a spherical surface to bring all the rays transmitted through it to a focus in one plane, so that when the margins of the image are in focus the centre is diffused. When the rays passing through the margin of the lens are brought to a focus nearer the lens than are the rays transmitted through the centre, the spherical aberration is said to be positive; when the contrary is the case, it is said to be negative. The flatter the surface of the lens which receives parallel rays from an object, the worse is the aberration. It is remedied by the use of a diaphragm or stop, but as this reduces the amount of light the lens manufacturer largely overcomes the trouble in another way; he combines two lenses, the one showing positive and the other negative aberration.

SPIKE OIL (Fr., *Essence d'aspic*; Ger., *Spiköl* or *Lavendelöl*)

Synonym, oil of spike lavender. It is a pale yellowish volatile oil with fragrant lavender odour obtained from the leaves and tops of *Lavendula spica*. It is used in some varnishes.

In process work, this oil is given in several formulæ as an addition to bitumen solution. It prevents the film drying brittle.

SPILLER'S REDUCER (See "Copper Chloride.")

SPINTHARISCOPE

Sir William Crookes's instrument for demonstrating the action of radium upon a fluorescent screen.

SPIRIT OF HARTSHORN (See "Ammonia.")

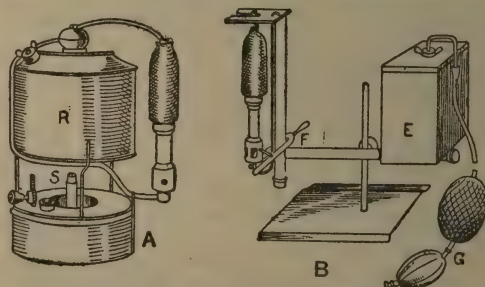
SPIRIT LAMPS (Fr., *Lampes d'alcool*; Ger., *Spirituslampen*)

Spirit lamps of different kinds are used for various photographic purposes, as in heating burnishers and solutions, warming negatives prior to varnishing, etc. They all consist essentially

of a reservoir for the spirit, having an earthenware or metal tube in which is placed a loose cotton wick. The flame given is hot and non-luminous.

SPIRIT LAMP, INCANDESCENT (Fr., *Lumière d'alcool à incandescence*; Ger., *Spiritus Glühlicht*)

A lamp in which a mantle coated with rare earths is rendered incandescent by vaporised and ignited methylated spirit. Such lamps are obtainable in various patterns for use in optical and enlarging lanterns. A typical model is shown at A. In this, the spirit, contained in the



Two Types of Incandescent Spirit Lamp

chamber R, is volatilised by means of the small spirit flame S, placed below it, the height of which is adjusted to a nicety by rack and pinion, thus controlling the pressure of the combustible vapour. The lamp can be brought into full action in a few minutes, and yields a light of 300 candle-power for a couple of hours. In another type of lamp, B, the spirit flows from a reservoir, R, along a tube filled with asbestos. To start the lamp, an asbestos fork, F, is moistened with spirit and lighted, the heat vaporising the spirit in the tube and causing the vapour to flow up the bend and down the narrower tube at the side to the burner, where it ignites. Once started, the heat of the incandescent mantle keeps up the supply of vapour, while the pressure may be increased at will by means of the rubber bulb G. (See also "Sol Lamp.")

SPIRIT LEVEL (See "Camera Level.")

SPIRIT PHOTOGRAPHY (See "Psychic Photography.")

SPIRIT OF SALT (See "Hydrochloric Acid.")

SPIRIT OF WINE (See "Alcohol.")

SPIRITUS GLONOI

Nitro-glycerine in a 1 per cent. alcoholic solution, and so named in the American Pharmacopœia. J. Vasant has recommended it as an accelerator for use with pyro.

SPIROSCOPE AND SPIROGRAPH

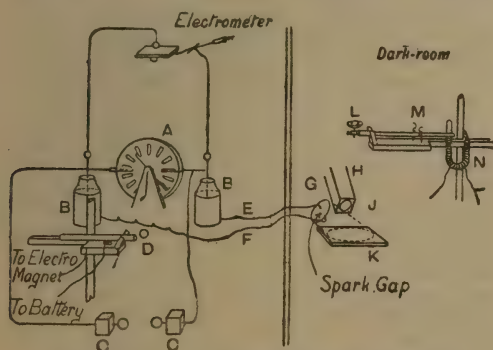
The former is the mechanical and optical apparatus used for viewing or projecting kinematograph pictures of microscopic size, the images of which are borne by a disc known by the second of the above terms. It is the invention of Theodore Brown and Charles Urban.

SPITZERTYPE

E. Spitzer's method of making process blocks. No details have been published, but the results seem to suggest that the basis of the process is the reticulation of the gelatine film on the lines of the Pretsch and Dallas processes.

SPLASHES AND DROPS, PHOTOGRAPHY OF

The photographs of splashes taken by A. M. Worthington, F.R.S., and R. S. Cole, M.A., and shown at the Royal Institution in 1894, were obtained by allowing a drop to fall in absolute darkness, and illuminating it at any desired stage by a Leyden jar discharge taking place between magnesium terminals. The following description is due to *Photography*. The spark was produced at the focus of a deep, silvered watch glass G (see diagram), subtending an angle of nearly 180° , and was brought very near to the place of impact. A single quartz spectacle



Arrangement for Photographing Splashes

lens, J, was substituted for the usual lens of the camera, H, and thus the absorption of photographic rays by glass was avoided. The diagram shows the arrangement of the apparatus. Simultaneously with the drop, a metal timing sphere, D, was allowed to fall between two other insulated spheres connected to the inner coats of two large oppositely charged Leyden jars, B B, standing on the same badly conducting table. C C indicate paraffin blocks. From the outer coats of the jars, wires E and F led into the dark-room, and there terminated in a spark-gap between magnesium terminals at the focus of a small concave mirror, consisting of a silvered watch glass. The Wimshurst machine, A, was turned till the lower ball of the rough electrometer shown was lifted up and struck a glass plate; then the sphere was liberated by tossing up by hand the remote end of the light, horizontal, pivoted rod which supported it. This broke the contact of crossed wires beneath the rod, cut off the current from the electro-magnet N in the dark-room, allowing an indiarubber catapult, M, to toss up one end of a similar horizontal lever, at whose other end the drop I, had been supported, without adhesion, on a smoked watch glass. By this means sphere and drop were left in mid-air, free to fall at the same instant. The sphere, in its fall, discharged the inner coats of the two Leyden jars, and this produced a simultaneous discharge at the spark-gap, between the outer coatings, thus illuminat-

ing the plate K. The timing of the spark was effected by adjusting the height of fall of the timing sphere by sliding the liberating apparatus up or down the vertical supporting rod. (See also "Bullets in Flight, Photographing.")

SPONGE BRUSH

The Buckle brush, described under the heading "Brushes."

SPOT CUTTER

An appliance for cutting number labels or white spots for lantern slides. The numbers are supplied printed on paper strips, and when one is required a strip is paid into a slot in the cutter till the required number is under a circular aperture. On turning a handle at the bottom of the cutter the number is cut cleanly out in the form of a round disc. The advantage is that it is much easier to cut out the numbers in rotation as required than to hunt for them in a boxful of loose labels.

SPOT, FLARE (See "Flare Spot.")**SPOTS ON PRINTS** (See "Black Spots," "Dust Spots," etc.)**SPOTTING MEDIUM**

A term sometimes given to the medium applied to a negative to allow spotting, etc., to be done, and sometimes to the material with which the spotting is carried out. For the former, see "Retouching"; for the latter, see "Spotting Negatives" and "Spotting Prints."

SPOTTING NEGATIVES

For spotting, a negative should be placed on a retouching desk in front of a window, and a sheet of white paper used as a reflector. For small spots, finely pointed lead-pencils form the best means of removal. Those marked H H, H, and H B will be best, the hardest being used for the smallest spots. Precision of touch is necessary, and the use of a magnifying glass is very desirable. It is essential that a touch be given with the pencil accurately on the spot; there is a risk of pencilling on the film round the spot, and so aggravating the defect. It is better to leave the spot slightly visible as a grey rather than attempt to remove it too thoroughly. It may show as a strong white spot on the print if worked too much. When spots are large, the pencil will frequently fail to be effective. In that case water-colour, applied with a brush or a fine mapping pen, will be better. The most suitable colour is either lamp-black or ivory-black, used in a very thin solution, so that it is grey rather than black. In many cases spots may be difficult to remove without showing on the print. The only course to adopt is to obliterate them thoroughly, so that they show as white spots on the print, and then touch them out on the print as described under the heading "Spotting Prints."

SPOTTING PRINTS

Bromide prints, platinotypes and carbon prints should be spotted, when required, with water-colour applied with a finely pointed brush; or a lead-pencil, H B, may be used for matt bromide

prints if they are not toned. Lamp-black water-colour will be the most suitable for black platinotypes, carbons and untuned bromides; while sepia and vandyke brown mixed in various proportions will allow any tint of brown carbon, bromide or platinotype to be matched. For glossy or semi-glossy bromide or silver prints a little gum may be added to the colour for spotting, and neutral tint and crimson lake added to the stock of colours will provide material for matching the tones of silver prints. No medium is necessary as a general rule, but occasionally the surface of a gelatine print will repel the colour. In that case, a very little prepared oxgall should be added to the mixed colour; it may be obtained at an artists' colourman's. Spotting should be done after the prints are mounted.

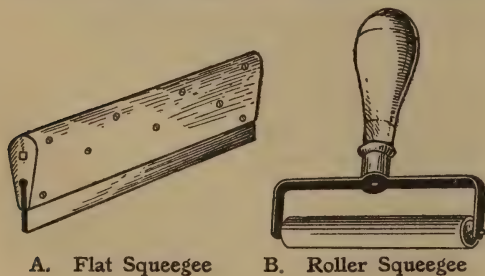
SPRINKLER (Fr., *Aspersoir*; Ger., *Sprengelröhr*)

A rose spray used for washing negatives and prints, and attached either to the end of a rubber tube connected with the water tap, or to a swing arm on the tap itself. A form of sprinkler is also made containing a filter in addition, to screw on any ordinary tap. Another kind of sprinkler consists of a metal tube like an inverted T, the horizontal arm of which is closed at the ends and pierced with a row of holes, while the end of the upright portion is connected to a rubber tube leading to the water supply.

Also the name given to any appliance for sprinkling or spraying the floors of dark-rooms and other photographic workrooms, to lay the dust.

SQUEEGEE (Fr., *Râcleur*; Ger., *Gummiquetsche*)

An appliance used for pressing wet prints into close contact with plate glass or ferrotype sheets when glazing; for rubbing prints down when mounting; and for various other purposes which require the application of pressure or call for the expression of moisture. There are two forms,



A. Flat Squeegee

B. Roller Squeegee

The flat squeegee, A, consists of a strip of thick flexible rubber mounted in a wooden handle, and is used by drawing it to and fro across the print. It is sometimes used to remove splashes of water and solution from the developing bench, etc. In the roller squeegee, B, a movable rubber roller is attached to a handle, the method of use being obvious. A pattern with two rollers is also made.

SQUEEGEE PAD

An accessory for glazing or matting prints. It consists of a sheet of celluloid, either glossy

or matt, placed between two covers of india-rubber cloth, which are fastened to it by one edge only. The prints are spread on the celluloid, film side down, and the indiarubber cloth laid over them, a squeegee being then applied in the usual manner. Both sides of the celluloid can be used. The rubber covers are then turned back and the celluloid sheet with the prints is hung up by means of a hook or pin passed through the edges of the covers. When dry, the prints fall off with a glazed or matt surface.

SQUEEGEE PLATE

A name for the pulp slab (*which see*). It is also applied to ferrotype plates and enamelled metal plates resembling them, employed in glazing prints.

STAGE PHOTOGRAPHY (See "Theatrical and Kinematograph Photography.")

STAIN REMOVERS

Acid solutions (usually hydrochloric and citric, combined with alum and sometimes with other substances) are used for clearing away stains caused by developers, particularly the pyrogallic acid developer. To 4 oz. of a saturated solution of common alum may be added 1 drm. of hydrochloric acid; there are many other formulæ. Chapman Jones has stated that acid stain removers are founded on wrong principles; the alum hardens the film and retards the washing away of stains, and the acid acts by lightening the colour of the stain, which, however, is rendered insoluble and is consequently fixed in the film. More satisfactory methods will be found described under the heading "Stains, Removing."

STAINS, REMOVING

Stains on Hands.—Pyro and some other developers stain the fingers by prolonged use; care must be taken to avoid putting the fingers in solutions, excepting when absolutely necessary. Any tendency to staining may be entirely obviated by rinsing the fingers and immersing them for a few seconds in an acid fixing-bath immediately after putting them in the developer. Rinsing and drying must follow at once. An acid fixing-bath or a solution of potassium meta-bisulphite will also remove stains of permanganate and many other photographic substances. It is a good plan to bathe the hands in hot water and then, before drying, rub glycerine into them.

Stains in Intensification.—Stains should not arise if the negative is in good condition and if all the previous work has been carried out correctly. Yellow stains that may appear during mercurial intensification are due solely to imperfect fixing of the negative. Insufficient washing after fixing will also cause staining. There is no method of removing these stains. In intensifying by silver, Wellington's method, surface staining may occur if the operation is very prolonged, the cause being the same as in a long or forced development. These stains may be easily removed by methylated spirit applied as directed under the heading "Reducing Negatives by Mechanical Means," or they may be treated by thiocarbamide or the "hypo" and ferricyanide solution.

Stains on Negatives.—When negatives show staining after development and fixing, the character of the stain will always indicate the cause and the cure. Iridescent markings round the edges of a negative are almost always caused by using old plates, especially if the plates have been kept under bad conditions or forced in development. They may be removed by means of thiocarbamide or by methylated spirit applied with friction. Surface stains, semi-iridescent, with rainbow-coloured markings, are sometimes seen on negatives otherwise perfect. These are due to scum on the developer, caused either by using the same solution for several plates in succession, or by mixing the developer in a measure without rinsing after previous use. A weak thiocarbamide solution will remove these stains almost instantly. A weak "hypo" and ferricyanide reducer will also remove them in a few seconds.

Stains on Prints.—Silver prints show yellowish-brown stains, semi-iridescent, if the surfaces cling to the dish or to another print during the first few seconds of washing in plain water before toning. These stains are most frequently attributed to "hypo," but they are in reality silver stains. There is no method of removing them satisfactorily. Similar stains may develop during fixing, or in the first washing water after fixing, if the prints are allowed to cling together; and they cannot be removed satisfactorily. Platinotype prints may develop yellow stains after washing and drying if the clearing has been imperfectly or carelessly performed. It is difficult to remove these stains without injuring the print; the best treatment is a strong solution of hydrochloric acid, 1 part of pure acid to 10 or 12 of water. Two or three successive baths of acid may be used, the prints being afterwards washed well. Prints on bromide or gaslight papers may be stained from the same causes as given under the sub-heading above, "Stains on Negatives." The treatment is the same, excepting that solutions about one-fourth of the strength are used.

STALE PLATES

Stale plates are distinguished after development and fixing by an iridescent or fogged edging round them; but there is no satisfactory method of telling whether a plate is stale previous to exposure and development. The deterioration of plates is caused more by an unsuitable atmosphere than by the mere lapse of time. When plates are known to be stale, a special restrainer, as follows, may be used with them:—

Potassium bromide.	2 grs.	·46 g.
Potassium bichromate	2 „	·46 „
Water	1 oz.	1,000 ccs.

Double the normal exposure will not harm very stale plates. When about to develop, take enough water to cover the plate and mix with it 30 drops of the special restrainer given above. Flow the mixture over the plate and rock for a minute or two; in a measure have ready any ordinary developer (not containing ammonia), and pour off the restrainer into the developer and return the whole to the plate and develop in the usual way; add more restrainer if fog appears. If the plates are exceptionally bad, a single drop of sulphuric acid may be added.

Development as above is very slow and the results hard, that is to say, very contrasty; thus, stale plates are useful for certain kinds of copying. The older the plates, the longer should be the exposure and the greater the quantity of restrainer used, and, of course, the harder the result.

STAMP PHOTOGRAPHS (See "Postage Stamp Photographs.")

STAND, CAMERA (See "Camera Stand," "Step-ladder Stand," etc.)

STAND DEVELOPMENT (See "Development, Stand.")

STANNOTYPE

A modification (1881) of the Woodburytype process, also invented by W. B. Woodbury. Instead of forcing the gelatine into a block of soft type metal by great pressure to make the matrix, the relief, made of bichromated gelatine, is faced with tin-foil.

STANNOUS CHLORIDE (See "Tin Chloride.")

STARCH (Fr., *Amidon*; Ger., *Stärke*)

$C_6H_{10}O_5$. A substance prepared from wheat, rice, Indian corn, potatoes, etc., and met with in the form of lumps or powder. Its principal photographic use is as a mountant. A variety of starch is arrowroot, which gives an almost clear solution when boiled, in which form it is used as a size for photographic papers, ordinary starch being sometimes used for the same purpose. Starch, when heated to about 400° F. (204° C.), is converted into dextrine.

STARCH MOUNTANT (See "Mountants.")

STARS, PHOTOGRAPHING

The various methods of photographing stars are so numerous that the most important of them will be best treated under special headings, as noted below. In general the science of astrophotography may be divided into two main classes, depending on whether the photographic camera is stationary, or is moved either by hand or clockwork so that the apparent motion of the stars across the field is neutralised.

Astrophotography with Stationary Camera.—There are numerous subjects with which valuable results may be obtained with no extra apparatus beyond an ordinary camera. Suppose the photographer wishes to prepare for himself an accurate chart of a certain constellation of stars. All that is necessary is to direct the camera, either by means of the tripod sliding legs or by some form of tilting table, to the middle of the constellation. The plates employed should be of the most rapid variety obtainable, and preferably panchromatic or uniformly colour-sensitive. When all is quite rigid, give an exposure of, say, ten or fifteen minutes with the largest stop available. On developing the plate a series of arcs of circles having different densities will be seen. These are the "trails" of the stars which were projected on the plate, the movement being due to the earth's rotation past the star during the exposure. Obviously, then, the length of the lines will depend on the

length of exposure. If, now, the beginning or ending of every star trail is marked with a small dot of Indian ink, of the same diameter as its corresponding line trail, the resulting series of dots will show as a star map. If the accompanying lines are found to be confusing, it is quite simple to trace the dots on tracing paper or cloth, when a star map will be obtained which may be placed in front of a small box containing a lamp. This contrivance will be found of great help to anyone wishing to teach the forms of the constellations, as the illuminated stars may be easily seen by a number of people at the same time.

Numerous other methods of utilising photographs obtained by fixed cameras will doubtless occur to the worker. For example, at the times of the year when it is known that a shower of meteors is expected, the camera may be directed to the proper position and left open for some time in the hope of a meteor flashing across the field of the lens. Many interesting pictures of these remarkable celestial visitors have been thus recorded. (See also "Meteor Photography.")

Astrophotography with Moving Cameras.—When it is desired to obtain accurate charts of the sky, the camera must be so mounted that by means of suitable clockwork the stars may be kept exactly on the same portions of the photographic plate throughout the exposure. The motion of the stars from east to west across the sky is at such a rate that a complete circuit of the heavens is made once in 24 hours. If the direction of motion be carefully examined, it will be found that all the stars travel in circles parallel to the equator, so that to follow them we must employ what is called an equatorial mounting; this consists of an arrangement whereby the axis of rotation can be tilted with respect to the horizon, until at any given place it is exactly parallel to the earth's axis. When this is accurately adjusted and the clockwork rated properly, it will be possible to obtain star photographs with any desired length of exposure.

With the apparatus above described it becomes possible to employ very powerful cameras, both as to aperture and focal length, so as to record stars so faint that they have never been seen by the unaided eye. The telescopic star cameras used in this way are of two kinds, depending on whether a refracting or reflecting system is used to give the image. The largest refracting lens telescope existing is that made for the Paris Exhibition of 1900, with a lens of 50 in. aperture and 180 ft. focal length. This is not in use, however, owing to the great expense of working.

The largest lens in actual use is that at the Yerkes Observatory, near Chicago, which has an aperture of 40 in. and a focal length of about 60 ft. Numerous reflecting telescopes are in use. The two largest now being used for photography are 60 in. in diameter; one, made by the late Dr. A. A. Common, is now at Harvard College Observatory, U.S.A.; the other, made by G. W. Ritchey, is at the Solar Observatory, Pasadena, California. This last is probably the most powerful telescope the world has ever known, and the resulting photographs are of

wonderful clearness and beauty. Many researches are being made with this 60 in. reflector which are quite beyond the scope of any other instrument, such as large scale photographs of the spectra of stars and planets, measurements of the velocities of stars in space, etc.

One of the greatest applications of the equatorially mounted star camera has been the "International Photographic Chart of the Sky," a co-operative scheme shared by all the nations of the world. This was inaugurated at Paris in 1887, when a congress of the world's astronomers resolved to prepare a photographic chart of the heavens, showing stars down to the fourteenth magnitude. This was to be supplemented by a second series of plates of short exposure, for a catalogue of stars down to the eleventh magnitude. The standard instrument was a twin refracting telescope—a photographic camera of 13 in. aperture and 11 ft. focal length, attached to a visual guiding telescope of 11 in. aperture. Each photographic plate covers about four square degrees of the sky. This magnificent work is now being brought to a successful conclusion, and the publication of the charts is well advanced.

A task of such magnitude is obviously not applicable to the detection of rapid changes in the positions or brightness of the stars. To provide information for this purpose Pickering, at Harvard College Observatory, has arranged for a complete photographic survey of the sky with a short focus camera. Copies of this work are obtainable, and it will be repeated at convenient intervals, so that a definite check will be possible on any changes in the positions or magnitudes of the stars.

For charting very condensed areas, such as the Milky Way, in which it is important to obtain a record of the general aggregation of the stars, the most successful method is that adopted by Barnard, who used at the Lick and Yerkes Observatories a small lantern lens of 2 in. aperture and 5 in. focal length. An apparatus of this type gives exquisite pictures of the star groupings when used with an efficient equatorial mounting.

Photography is now used for systematically recording the brilliancy of stars. This is done by obtaining photographs with the plate slightly displaced from the true focus for parallel rays, so that the image of each star shows as a small round disc instead of a very tiny point. A series of standard density squares from a standard light source are impressed on the plates before exposure to the sky; it is therefore possible by measuring these density squares and the star discs to obtain accurate values of the relative brightness of the stars.

Planet Photography.—This is so much beyond the reach of the ordinary photographer that it is only suitable here to give a short outline of the results obtained by the photographic astronomer provided with the very special equipment necessary for the purpose.

The first successful attempts to obtain pictures of the planets showing the details of their surface markings were made by Gould, at Cordoba, in 1879, on the planet Mars, and by Dr. Common in the same year on Jupiter. The earliest satisfactory photographs of the wonder-

ful planet Saturn, with his accompanying system of rings, were obtained by M. M. Henri, at the Paris Observatory, in 1885.

Mars has always proved a fascinating object on account of its being our nearest celestial neighbour after the moon, and, further, it is thought that the conditions of its surface are somewhat similar to our own—that is, there seems good reason for believing that land and water are present in separated masses as on our earth, and the presence of ice is also very probable. The photographs of Mars show very clearly that the surface of the planet is irregularly divided into dusky and light patches, and at the two diametrically opposite points corresponding to the axes of rotation, there are small oval patches of intensely white material, which are generally considered to be the snow caps at the extremities of the poles of the planet, corresponding to our Arctic and Antarctic regions of perpetual ice and snow. This view is rendered more feasible by the further fact that these white polar caps are found to vary regularly in extent, getting smaller and smaller as the summer season on the planet approaches, and gradually increasing again on the advent of the Martian winter.

Some of the most beautiful photographs of Mars have been taken by Professor Lowell with his telescope of 24 in. aperture, at Arizona, on an elevated plateau well up out of the lower strata of our atmosphere. He has also succeeded in photographing several of the peculiar thread-like markings called "canals," which have caused so much controversy among astronomers during the last twenty years.

Excellent photographs have also been taken by Barnard at the Yerkes Observatory, and by Hale at the Mount Wilson Observatory. The general equipment is the same, and consists of the largest and most perfect telescope that the observer can command; to this is applied the highest power magnifier that the objective and atmospheric conditions will stand, and also photographic plates of special rapidity and colour sensitiveness. The atmospheric conditions vary so rapidly that for such objects as planets it is usual to arrange the plate holder as a repeating back, fitted to take a great number of pictures at short intervals on the same plate, so that the few times of best definition may perhaps be caught among a great number of mediocre ones.

Jupiter, although not productive of such great discussion, offers many features for which the application of photography is eminently suitable. This planet is apparently clothed in clouds, and these are arranged in broad belts parallel to the planet's equator, showing as bands of alternately light and dark material on the photographs. In one of them there is a remarkable feature called the "Great Red Spot," a large oval patch of ruddy colour which has been visible now for many years. It is hoped that large scale pictures of this phenomenon may definitely decide the relation of its drift among the surrounding cloud belts, and later, possibly, its true character.

Saturn is the furthestmost of the planets of the solar system of which satisfactory photographs have been obtained. Numerous

excellent pictures have recently been taken at the Lowell Observatory, showing most minute detail on the cloud belts and the surface of the rings.

Uranus and Neptune, the two outermost planets, have been often photographed, but their images so far have only been small discs without definite surface detail.

The minor planets are a closely associated swarm of small bodies revolving round the sun in orbits between Mars and Jupiter. The majority of them are so small as usually to be unobservable even with the largest telescopes, and they have nearly all been discovered by means of their trails on photographic plates exposed for long periods to the sky. The early part of this work was done by moving the telescopic camera at the same rate as the earth's rotation, so that each photograph showed all the stars as minute bright points. If then an object was found showing an elongated image, and it was decided to be a real marking, it was assigned a provisional number as a new planet, and after full confirmation on subsequent photographs a name would be given to it. Lately an ingenious method has been devised to permit of the discovery of small planets being recorded which, if left to trail, would be too faint to give any perceptible image. Sufficient is now known of the general motions of this belt of small planets to allow of their probable velocity in any region of their orbit being fairly accurately calculated. The camera is then set to travel at this velocity, instead of at the earth's velocity as before. This means that the little planet will now be able to accumulate its light on the image on the plate, and it will thus show up as a small round point among the surrounding stars represented by short elongated trails. The plates used should be of the fastest emulsion available, consistent with a fine grain.

Nebulæ Photography.—This branch of photographic astronomy is almost beyond the reach of the camera alone. There are only one or two nebulæ which can be photographed with rapid exposures, and then only on a very small scale, scarcely repaying the trouble which may be taken. With a small expenditure, however, a very serviceable driving mechanism may be obtained or constructed by the observer, and then very interesting pictures of the chief nebulæ may be photographed without any greater difficulty than is experienced in taking high-power telephotographs. The focal length of lens to be selected depends to some extent on the object selected for experiment. Thus the nebulæ of Orion, Andromeda, the Magellanic Cloud, the Pleiades, and other objects of considerable extent give very beautiful pictures with cameras of quite moderate focal lengths, say from 12 to 30 in. Naturally on such objects the lens should be of the largest relative aperture possible, as then the exposure necessary will be the minimum, and the chances of disturbance during the operation reduced as far as possible. The range of gradation is so great that the utmost care should be taken with the development, a moderately dilute solution of any of the standard formulæ being suitable. All plates should be thickly backed, otherwise the star images distributed over the region will be so

expanded as to detract seriously from the value of the picture.

The famous Orion, or "Fish Mouth," nebula was first satisfactorily portrayed by photography by Draper, in 1880. Later magnificent pictures were obtained by Dr. Common in 1883, at Ealing, with a large silvered glass reflector, 36 in. in diameter, which he had himself entirely constructed. With further advances in the rapidity of photographic plates and perfection of apparatus it was possible to delineate greater and fainter extensions, and also by employing instruments of enormous length the fine detailed structure was for the first time brought to our knowledge. The greatest advances of recent years were made by Keeler, at the Lick Observatory, California, and Ritchey, at the Yerkes Observatory, near Chicago. The former made an extensive survey of the class of nebulae whose structure is distinctly spiral, and published an atlas of beautiful reproductions of the most important. Ritchey has more specially aimed at obtaining specially large-scale pictures of the principal nebulae, showing the wonderful relationships existing between the cloud-like wisps and the star aggregations with which they are apparently associated. The study of these pictures is of the greatest importance.

STATUARY, PHOTOGRAPHING

Statuary should always be photographed in a light as softly diffused as possible in order to secure roundness and softness; but in order to secure contrast it is necessary that the direction of the lighting should be from one side, and sufficiently pronounced to give shadows and relief. In most cases a point of view towards one side will be the most satisfactory, and this should be the opposite side to that from which the light is coming. Occasionally, however, a full front view must be taken. A dark background, which will show as a dark grey in the print, should be used when possible, though in many cases the photographer will have very little choice. In outdoor statuary, dark foliage at a distance from the group will form a good background, and direct sunshine must be avoided. When a suitable background cannot be obtained, double-printing should be adopted.

A good method of determining the exposure for groups of statuary is by means of a meter, the meter being held close to the statuary and facing the camera. Using lens aperture $f/16$ and a plate 200 H. and D., the exposure for a single figure or small group of white statuary, not more than 5 ft. or 6 ft. high, will be one-tenth of the time that the meter requires to match its standard tint if a Wynne meter is used, and one-twentieth for a Watkins. For bronze or dark figures, one-fifth of the Wynne meter time, and one-tenth of the Watkins, should be given. Large groups, 10 ft. or 12 ft. high, will require half these exposures.

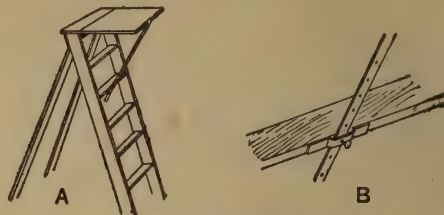
STELLAR PHOTOGRAPHY (See "Stars, Photographing.")

STENOPAIC PHOTOGRAPHY

Synonymous with pinhole photography.

STEP-LADDER STAND

A type of camera stand, largely used in France for street views, etc., when it is desirable to have the camera in a position above the heads of the spectators or pedestrians. The type most widely



Step-ladder Stand

used consists of a step ladder of a convenient height to the top of which is hinged a table upon which the camera is screwed, the table and camera being adjusted by means of strut B.

STEREOPTICON

The American name for the optical lantern.

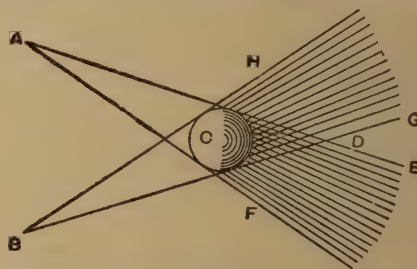
STEREOPHOTODUPLICON

An arrangement for taking stereoscopic photographs, invented by Theodore Brown and described under "Stereoscopic Photography."

STEREOSCOPE (Fr., *Stréoscope*; Ger., *Stereoskop*)

An optical instrument for uniting into one image two plane representations as seen by each eye separately, and giving to them the appearance of relief and solidity. The subject of binocular vision was studied by various optical writers who have flourished since the time of Galen. Baptista Porta, one of the most eminent of them, repeats, in his work "On Refraction," the propositions of Euclid on the vision of a sphere with one and both eyes.

Leonardo da Vinci referred to the dissimilarity of the pictures seen by each eye as the reason why "a painting can never show a



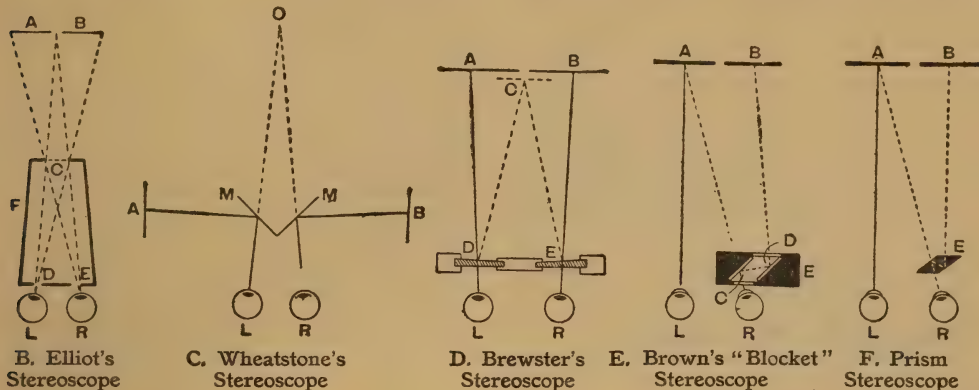
A. Diagram Illustrating Stereoscopic Relief

relievo equal to that of the natural objects, unless these be viewed at a distance and with a single eye," which he thus demonstrates. If an object, c (in diagram A), be viewed by a single eye at A, all objects in the space behind it—included, as it were, in a shadow E C F, cast by a candle at A—are invisible to that eye; but when the other eye at B is opened, part of these objects become visible to it, those only

being hid from both eyes that are included, as it were, in the double shadow CD cast by two lights at A and B , and terminated in D ; the angular space EDG , beyond D , is always visible to both eyes. The hidden space CD is so much shorter as the object C is smaller and nearer to the eyes.

Elliot was the first to construct a stereoscope; but as it was devoid of lenses, the coalescing of the two pictures depended upon a somewhat

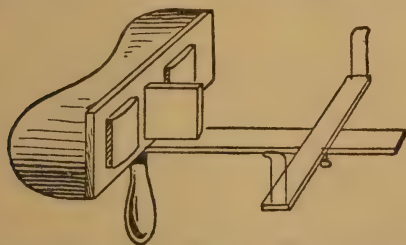
scope," the fundamental principle of which forms the basis of all modern instruments. He conceived the idea that if prisms or sections of complete lenses were used to divert the rays coming from two pictures placed side by side, so that their images were thrown to a common centre, the evils of reflection obtaining in all reflecting instruments would be altogether dismissed. Diagram D shows his instrument. A



unnatural accommodation of the eyes. In a box, F (see diagram B), he made apertures, D and E , and at the opposite end a single aperture C . The pictures to be combined were placed at a distance behind the box, with the picture belonging to the left eye at B , and the picture belonging to the right eye at A . On placing the eyes at L, R their axes crossed at C , and then, by a slight effort in focal accommodation to AB , the two pictures A and B were seen combined and presented the desired illusion. Only persons possessing the power to accommodate the focus of the eyes to a remote plane whilst

and B represent the pictures; D and E are a pair of prisms fitted to a suitable framework and with their thinner edges turned towards each other. On placing the eyes at L, R , the pictures A, B are seen at a common point C , and stereoscopic solidity and relief results. Brewster soon found that the use of sections of convex lenses effected the necessary refraction, and at the same time provided magnifiers. The best-known form of Brewster's Lenticular Stereoscope is that of a tapering box, with the lenses at one end, and at the other a groove for the reception of the pictures. The box contains further a ground-glass panel at the back, so that when transparencies are under observation they are viewed by transmitted light; while for opaque pictures, the box is fitted with a reflector hinged at the top.

Dr. Oliver Wendell Holmes, of America, in 1861, invented a form somewhat like that illustrated at G , but without the sliding view-holder, the latter improvement being added by Joseph L. Bates, of Boston, in 1864. The design shown at G has become universal. There are some persons, however, who experience considerable difficulty in seeing stereoscopic views properly with this class of instrument, the reason generally being that the pupillary centres of their eyes are not close enough together or far enough apart to suit the index of refraction and magnification of the lenses of the particular stereoscope in use. To obviate this difficulty, stereoscopes have been designed with means for varying the separation of the lenses, Baird's Lothian stereoscope being a good example of this type of instrument; the proper distance for the pictures in relation to the lenses is arrived at by sliding the view-holder along parallel carrying tubes, the latter being detachable so that the instrument may be used for the examination of stereoscopic prints mounted in albums.



G. Bates's Improvement on the Holmes Stereoscope

their axes were converged to a nearer plane, could obtain the desired result. Wheatstone's "Reflecting Stereoscope" (C) proved to be the first practical stereoscope. Two plane mirrors MM , set at an angle of 45° , reflect the stereoscopic pictures A and B into the eyes at L and R , so that the combined result is seen somewhere in the direction of O . The mirrors are fixed, but the distance between A and B is made adjustable by a screw, threaded (left and right) at each end.

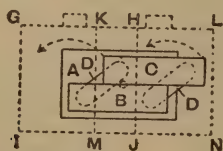
Sir David Brewster, who appears to have been investigating stereoscopic phenomena at the same time as Wheatstone, devised what is known as the "Refracting or Lenticular Stereo-

Theodore Brown's "Blocket" instrument (see E) is probably the smallest stereoscope. It is based on the laws of reflection, and acts as follows:—Let the pictures be represented as situated at A B, the eyes of the observer at I, and R, and the optical part at E. The left eye I sees its picture by direct vision from I, to A. Inside the small casing E two mirrors are fixed facing each other, but not quite parallel. The right eye R sees in the mirror C an image of the picture B by reflection from mirror D, and, by a suitable adjustment in the relative angles of these two mirrors, B is superimposed upon A, where stereoscopic fusion takes place. If a prism of the shape of the space between the mirrors C and D is substituted for the mirrors and the casing is dispensed with, a prism stereoscope (shown at F) is the result, and the light will be acted upon precisely in the same manner and with the same result.

STEREOSCOPIC CAMERA (See "Stereoscopic Photography.")

STEREOSCOPIC PHOTOGRAPHY

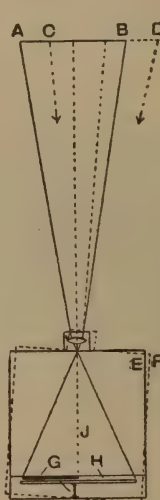
The invention of the stereoscope being prior to the discovery of photography, the first pictures for this instrument consisted of line drawings. With the advent of photography, the stereoscope became increasingly popular, as this discovery provided the means of reproducing the minutest details of a subject binocularly with absolute precision. To secure a photographic slide for the stereoscope, it is necessary that two distinct photographs of the subject be taken from standpoints corresponding to the positions of the two eyes, and that these photographs be mounted side by side. If the subject is still-life, the two pictures may be taken by successive exposures, moving the camera between them a distance of $2\frac{1}{2}$ in. to 3 in. To facilitate the operation, various contrivances have been devised, an example of which is shown at A, in which A is a slab of wood having attached to its upper surface two narrower strips B C linked together at D parallel-rule fashion. B is fixed to the base A, while C



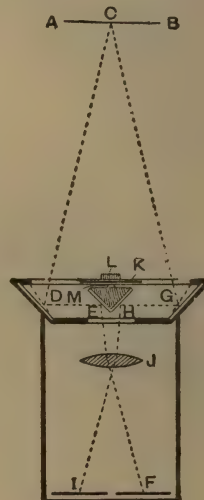
A. Arrangement for Stereoscopic Photography with Single Camera

is free to swing. The camera to be used is secured to C and rests lightly on B. With the camera in the position indicated at K I, M N, the first exposure is made, which will give the picture belonging to the right eye. The strip C carrying the camera is now moved so that the camera occupies the position indicated at G H I J, when the second (left eye) picture is taken. Another method of stereo-photography with a single camera and by successive exposures is indicated in diagram B, in which E represents

in plan a camera turnable on its axis at J. If the dark-slide, holding a plate, is furnished with an opaque card just half the size of the plate itself and loose enough to be shaken from one end of the dark-slide to the other without opening the slide, the two photographs of one subject may be obtained on a single plate. The picture for the right eye is secured with the camera in the position indicated in full line, covering the field between A B, half the plate only at H being at first exposed. The dark-slide is then closed and withdrawn from the camera for the purpose of shaking the opaque card from G to H; it is re-inserted in the camera and the shutter drawn out so that the portion of the plate at G may now be exposed. Before uncapping the lens, however, the camera is turned slightly from left to right, so that it covers the field between C D. A stereoscopic



B. Another Arrangement for Stereoscopic Photography with Single Camera



C. Brown's Stereophoto-duplicon

pair of images will thus be impressed upon one plate. Further, if the operation be carried out in the order indicated no transposition of the finished prints will be required. Stereo-photography by the successive exposures and displacement system, whilst being useful for still-life or fixed subjects, cannot be adopted with success in cases where movement of any part of the subject is likely to occur, or when the illumination of the subject is liable to alter. The most perfect results for the stereoscope can only be obtained when the two images are received upon the plate simultaneously. It is not, however, impossible to do this with a single-lens camera. For example, in Brown's stereophoto-duplicon (C) there is a chamber forming a supplementary extension of an ordinary camera. In the chamber are placed four mirrors as at D E H G. Let A B represent the subject to be photographed. Taking the centre ray, the light coming from C strikes the surface of the two outermost mirrors D G, is reflected to E H, thence through the lens

j to the plate *IF* at the back of the camera. Images from the binocular angle are thus secured simultaneously on one plate and at one exposure, and as the light crosses before reaching the plate the pictures are taken so that the negative yields a pair ready transposed for immediate inspection in the stereoscope.

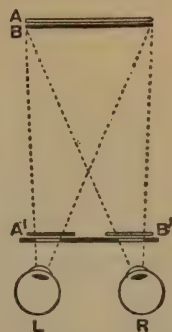
A modification of the apparatus just described is that of the so-called stereoscopic transmitter, in which only two mirrors are employed, set at an angle to each other and placed at an angle of about 45° in relation to the axis of the lens of an ordinary camera. Transposition of the images takes place before the light reaches the sensitive plate. The mirrors are surface-silvered and of the kind used in reflex cameras.

The ideal apparatus for stereoscopic photography consists of a camera furnished with a pair of carefully matched achromatic and rectilinear lenses of 5 in. to 6 in. focal length duly corrected for spherical aberration. The distance between two such lenses should be adjustable, so that for near subjects their separation may be reduced to 2 in., or for remote subjects increased to 3 in. or $3\frac{1}{2}$ in. The mechanism controlling the opening and closing of the two shutter apertures should be such as to ensure absolutely synchronous working. Lenses of a shorter focal length than 5 in. are unsuitable for stereoscopic work, as they appear to give an exaggerated perspective which is especially noticeable in architectural subjects. Again, too great a separation of the lenses on a stereoscopic camera induces abnormal relief in the stereoscope, besides making it difficult for the two pictures to be seen blended together at all planes in the composition.

The actual practice of stereoscopic photography, once the principle has been grasped, is simple. Exposure and development are as usual, taking great care, however, when the two images are on separate plates, to obtain results as uniform as possible. Hand-work on the negative is not desirable, and, indeed, will militate against success. It is only in the transposition of the prints that there is any difficulty. It has already been shown that by some methods of stereoscopic photography, transposition of the prints is not necessary. Again, it is possible to cut the negative and to transpose the halves in a special printing frame so that the print obtained is suitable for use without alteration; but in the case of photographs taken in two-lens cameras, and when the negative is not cut before printing, the following procedure will be necessary: Lay the print face downwards, and lightly mark the edges of the print so that the sequence of the images can be recognised at a later stage. Assume that, as the print lies face down, the image on the left is No. 1, and that on the right No. 2. Carefully trim, leaving on the right of the right-hand print $\frac{1}{4}$ in. more of the picture than appears on the left-hand print; in the same way leave on the left of the left-hand print $\frac{1}{4}$ in. more of the picture than appears on the right-hand print. Next sever the two images and mount the prints, being careful to place them about $\frac{1}{4}$ in. apart. Looking at the face side of the prints, No. 1 will be on the left and No. 2 on the right.

STEREOSCOPIC PROJECTION

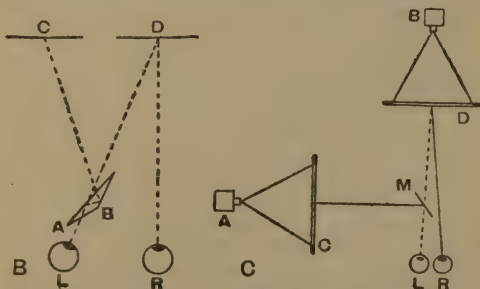
The projection of a pair of stereoscopic pictures in such a manner that each eye of the observer shall see but one image, the one belonging to it. In 1841 Dove showed that if one of a pair of stereoscopic pictures is outlined in blue on a white ground, and the other element



A. D'Almeida's System of Stereoscopic Projection

in red, the two being approximately superposed upon the same sheet, a spectator furnished with red and blue glasses will see the outlines as a single solid image. In demonstrating this fact Dove obviously foreshadowed the work of Ducos du Hauron. (See "Anaglyph.") De la Blanchère and Claudet, some years later, attempted to eliminate the use of the spectacles.

J. Ch. D'Almeida, in his communication (1858) to the French Academy of Sciences, described how he placed in the course of the luminous rays two coloured glasses (red and green); the observer views the projections through glasses of similar colours, the fusion being seen as a black and white combination in stereoscopic relief. D'Almeida's system is shown at A. A represents the green image on the lantern screen, and B the red image; the



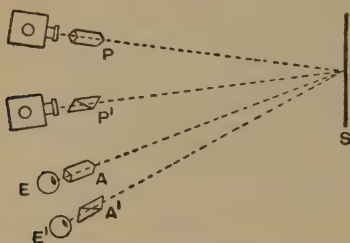
B and C. Drouin's and Moessard's Systems of Stereoscopic Projection

former is blotted out with the green spectacle glass B^1 , so that the right eye *R* sees only the red image *B*. Likewise, the red image is blotted out by the red glass A^1 , so that the left eye *L* sees only the green picture *A*. Many modern experimenters have modified the above system. It has been suggested that, instead of using two separate projections, similar results may be obtained by making a composite slide and projecting the same by a single lantern.

D'Almeida also invented the eclipse system in which a perforated shutter rotates in front of side-by-side lanterns. Another form of eclipse system, but of small practical value, consists in using a box apparatus similar to Elliot's stereoscope.

There are numerous ways in which stereoscopic elements when projected side by side upon a screen may be united so as to produce the desired results. Drouin, of France, suggested the system shown at B. The stereoscopic elements *C* *D* being projected by a lantern, *D* is seen by the right eye, *R*, direct, and *C* by reflection in the prism. The light emanating from *C* impinges at *B*, is deflected to *A* and thence to the left eye *L*. The left eye, therefore, sees the image of *C*, superposed on the image *D*, where union takes place and stereoscopic effect results.

Moessard used two prisms, mounted opera-glass fashion. *C* shows an arrangement by which a single mirror *M* suffices to superpose a second image of the necessary pair upon its complement image *D*. Two lanterns *A* *B* are used to project their respective elements upon lantern screens, *C* *D*. The observer, with his eyes situated at *L*, *R*, sees one element, *D*, by



D. Anderson's System of Stereoscopic Projection

direct vision, and the companion element, *C*, by reflection in the mirror, stereoscopic relief resulting. There is a number of similar systems.

In 1890, Anderson, of Birmingham, invented stereoscopic lantern projection by means of polarised light. Two lanterns project the elements in superposition upon the screen *S*, in diagram D. Before each lantern is a polariser *P* *P'*. The picture received by the screen is thus formed of two polarised pictures; for instance, one in a vertical, and the other in a horizontal position. The observer looking at the composite picture through analysers *A* *A'*, placed before his eyes, *E* *E'*, will see with each eye its proper element, and fusion results. The fact that light is lost in polarisation and depolarisation somewhat discounted Anderson's method; but to rectify matters a flexible screen having a metallic reflecting surface was introduced, and this also had the merit of preventing depolarisation apart from the analysers. Anderson also constructed his polarisers and analysers of bundles of thin glass, like the microscopic cover glass, and set at about the polarising angle. The glasses in the bundles are not set quite parallel to each other; otherwise ill-defined images would result, owing to disturbing reflections. Many of the systems above described are obviously applicable to the kinematograph,

and, indeed, almost all have been tried with varying success.

Direct Stereoscopic Projection.—All the foregoing systems may be termed indirect methods of stereoscopic projection, inasmuch that in every case the final results are observed after looking through coloured glasses, prisms, mirrors, shutters or other devices; but as long as intermediate agencies are necessary, stereoscopic relief upon the lantern screen will remain commercially impracticable. The only systems of direct stereoscopic lantern and kinematograph projection have been evolved by Theodore Brown. One applies to ordinary lanterns and the other to the kinematograph. The former consists of a special carrier furnished with a plurality of glass slides or films carrying different sections of one subject in panoramic order and with varying speeds according to the supposed distance of each plane in the composition of the subject depicted. Remote mountains are depicted on one glass or rollable film; the middle distant objects (ships) on a second one; and foreground objects (trees, etc.) on a third. The mechanism of the carrier through which the three glasses are caused to slide horizontally is such that the first has hardly any movement, the second moderate movement, and the third quick movement. On the screen, and before the mechanism is set working, the composition appears as an ordinary picture; but on operating, and thus imparting the panoramic and varying movements, the observer at once perceives a depth of perspective, such as is apparent in any ordinary stereoscope. The fast-moving foreground appears decidedly at a near plane, the sea and ships at a distance beyond the foreground, and, finally, the remote mountains at a great distance away. With this impression comes the sense of actual space between foreground and background. In complicated subjects as many as six distinct layers of rollable films have been introduced.

In Brown's direct system as applied to kinematographs, there are four chief modes of procedure: (1) Placing the subject on a rotatable stand revolved synchronously with the working of the taking camera; (2) Causing the camera to circumscribe the subject, by making the former travel round the subject at a speed regulated by the working of the camera; (3) Using the camera on a special tripod head, designed to give an oscillation to the camera whilst in operation; and (4) Taking the subject in a continuous panoramic direction, at a speed of operating according to the movement of the vehicle carrying the camera.

STEREOSCOPIC SPECTACLES

Spectacles at one time largely used for viewing stereoscopic prints. They are even now used for viewing stereoscopic photographs in books and at times when the prints cannot be placed in a stereoscope. The earliest form of stereoscopic spectacles was made by Duboscq, of Paris, about 1852. Later he introduced spectacles which were actually skeleton box stereoscopes. John Parker, in the late 'fifties of the last century, made spectacles which were worn on the nose, but were encumbered with a division plate or blind on the bridge.

Stereoscopic spectacles of a different kind are used for inspecting anaglyphs. (See "Anaglyphoscope.")

STEREOSCOPIC VISION

A term used in reference to the power to see stereoscopic images coalesced without the aid of any instrument whatsoever. Briefly, it consists in directing the eyes' axes to a remote plane whilst accommodating their focus to a near plane. As this operation involves strain and considerable practice before it can be successfully accomplished, various suggestions have been made to assist the observer to train his eyes in the acquisition of this power. Probably the most successful method of acquiring the power to see stereographs stereoscopically without an optical instrument is the following:—



Diagram Illustrating Stereoscopic Vision

Referring to the diagram, cut a strip 1 in. wide out of both the right- and left-hand prints of a stereogram. The portions selected should show remote as well as near objects, and the foremost object should occupy the centre position in each strip. Obtain a piece of cardboard (preferably dead black) $1\frac{1}{2}$ in. wide and about 6 in. high; bend this at right angles in the centre, so that half may lie flat on a table, while the other half will stand erect. Place the two strips of view at A B, side by side, supported at the back, and at a distance of about 3 ft. from them place the cardboard E. Lower the eyes L R so that they are just above the level of the table top and at a distance from E of

about 7 in., and in such a position that the left eye L sees only the strip A, and the right eye R sees only the strip B, each eye being prevented from seeing the other strip by the shutter card E.

As the two corresponding points in the views A and B have a separation only of 1 in. instead of $2\frac{1}{2}$ in. or 3 in. as in ordinary stereoscopic slides, the eyes are easily made to diverge their axes to this slight extent; and the result is the two pictures combine and stereoscopic relief results. Having succeeded in coalescing A and B in this position, their separation may be gradually increased, until corresponding points reach $2\frac{1}{2}$ in. This done, ordinary full-sized views may be substituted for A B, and when by practice in this manner the observer has learnt the secret of muscular control of the axes of the eyes, he may dispense with the cardboard.

STERRY'S PROCESS

A process of obtaining soft bromide prints from very hard negatives, introduced by John Sterry. The exposed paper is immersed for about a minute in a $\frac{1}{2}$ per cent. solution of potassium bichromate, washed and developed in the usual way, double the customary time being necessary. It will be found that the shadows retain much gradation. The colour of the image is not interfered with, and the process is also available for lantern plates.

STIGMATIC LENS

A lens free from astigmatism (fully described under its own heading). In addition, it is free from chromatic and spherical aberration.

STIGMATYPE

A process of producing pictures by setting up type characters consisting of dots, squares, etc., forming a sort of half-tone image; introduced by Carl Fasol Pflöge, in Vienna, in 1868.

STIPPLE (Fr., *Pointillage*; Ger., *Punktierung*)

In retouching, working-up enlargements, etc., the covering of surfaces or filling-in of spots and imperfections with small points or dots, whether applied by pencil, brush, or crayon. The operation is known as stippling, and the dotted or grained work, however produced, as the stipple. (See "Retouching.")

In process work and lithography, "stipple" is a style of shading produced by making dots with a fine brush in a regular geometrical pattern, usually in small curves. By varying the size and spacing of the dots, great variety of light and shade is produced. Copper- and steel-plate engravers produce a similar stipple by means of a needle-point penetrating an etching ground. Process workers usually obtain their stipples ready made on copper plates, from which transfers are taken, or by means of shading mediums

STIPLETTE

A method of quickly and mechanically imitating the effect of sable brush stippling and hatching, introduced by T. S. Bruce, of Hampstead, in 1906.

STOCK SOLUTIONS (See "Solutions, Making up.")

STONE, PRINTING ON (See "Marble, Photographs on.")

STOPPERS, REMOVING FIXED

Prevention being better than cure, both necks and stoppers of glass bottles should be lubricated with tallow, vaseline, etc. The various methods of removing stoppers have been summarised as follows:—(1) Press the stopper (longways) in one direction with the thumb (grasping the bottle with the fingers of the same hand); now with the other hand hold a chisel or file by the iron part and tap the opposite end of the stopper in the contrary direction to which you are pressing it. (2) Place the stopper in or under a clamp—as that of a carpenter's bench—first wrapping something soft round it, as a piece of leather or wool. Considerable leverage can thus be obtained, but it must not be used to too great an extent or the stopper will snap off. (3) A substitute for the wooden clamp is the use of a key whose handle is just large enough to go over the wrapped-up stopper. These three may be termed the mechanical methods. The use of heat is also very effective in expanding the neck of the bottle. For this purpose we may (4) invert the bottle and dip stopper and neck into a saucepan of hot water. A string should be tied round the stopper or it may drop out and the contents of the bottle be lost. (5) Rotate the neck of the bottle rapidly in the flame of a Bunsen burner.

This is a very effective method, but requires care. (6) Take one turn of a stout piece of string round the neck, and then by means of the two ends saw the string rapidly backwards and forwards. The heat produced by friction will cause the neck to expand."

Stoppers may become fixed owing to the evaporation of their contents, the solid matter crystallising between the neck and the stopper. The remedy is to pour some of the solvent used to make the solution round the stopper and renew as may be necessary, giving it time to work its way between stopper and neck.

STOPPING-DOWN

The use of a smaller stop to decrease the aperture of a lens with the object of improving the depth of focus or definition, of reducing spherical aberration to a negligible quantity, etc. (See "Diaphragms.") Stopping-down directly affects the duration of exposure, as explained under the heading "Exposure Tables."

STOPPING-OUT (See "Blocking-out.")

STOPPING-OUT VARNISH

A black or coloured shellac or asphalt varnish or lacquer used by process etchers for stopping-out the portions of plates which have been sufficiently etched, so that these parts are protected whilst the remaining portions can be re-etched.

STOPS (See "Diaphragms.")

STRESS MARKS

Synonymous with abrasion marks (*which see*).

STRIPPING FILMS (See "Film Stripping.")

STRONTIUM BROMIDE (Fr., *Bromure de strontium*; Ger., *Strontiumbromid*)

Synonym, bromide of strontia. $\text{SrBr}_2 \cdot 6\text{H}_2\text{O}$. Molecular weight, 355.5. Solubility, 1 in 1 water; 1 in 30 alcohol. It is in the form of small colourless crystals, obtained by neutralising hydrobromic acid with strontium hydrate or carbonate. Occasionally it is used in collodion emulsions.

The anhydrous salt, SrBr_2 , molecular weight 247.5, occurs as a white and very hygroscopic powder.

STRONTIUM CHLORIDE (Fr., *Chlorure de strontium*; Ger., *Strontiumchlorid*)

Synonym, chloride of strontia. $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$. Molecular weight, 266.5. Solubilities, 1 in 1.33 water; slightly soluble in alcohol. It occurs as white needles, obtained in a similar manner to the bromide, and it is used for making chloride emulsions.

The anhydrous salt, SrCl_2 , molecular weight 158.5, also occurs as a white powder; solubilities, 1 in 1.96 water, slightly soluble in alcohol.

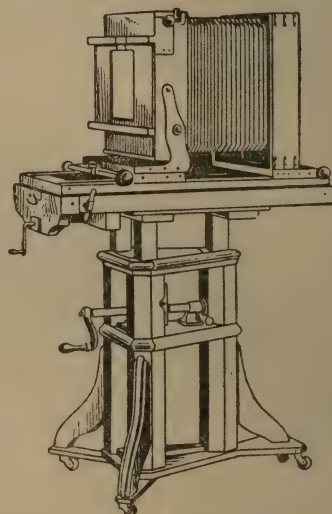
STRONTIUM IODIDE (Fr., *Iodure de strontium*; Ger., *Strontiumiodid*).

Synonym, iodide of strontia. $\text{SrI}_2 \cdot 6\text{H}_2\text{O}$. Molecular weight, 449. Solubilities, 1 in .56 water; soluble in alcohol and ether. It is a yellowish granular powder, prepared like the bromide. It is used the same as the bromide.

The anhydrous salt has the formula SrI_2 . Molecular weight, 233.5.

STUDIO CAMERA (Fr., *Chambre d'atelier*; Ger., *Atelier Kamera*)

The studio camera requires to be substantially made, rigidity and strength being here of primary importance, while portability is of secondary importance. It should have a swing back, a rising and falling front, and, if possible, a long bellows extension for use in copying. The illustration shows a typical studio camera and stand. It is furnished with a rack and pinion at both front and back, so that the camera can be racked backward or forward at either end. Each end has a draw-out extension in addition. Extending supports beneath the bellows prevent



Studio Camera

"sagging." The top of the stand has a tilting table worked by an Archimedean screw operating on an eccentric block, while for raising or lowering the camera a screw cog movement is provided. The dark-slide has a roller shutter, and is fitted with carriers for the smaller sizes of plates. Some workers prefer to have the focusing screen and dark-slide running side by side in grooved rails at the back of the camera, as then the ground glass may instantly be pushed out of the way after focusing and the slide simultaneously brought into position. Such an arrangement is often provided in connection with the repeating back.

STUDIO DESIGN AND CONSTRUCTION

The studio, or "glass-house," as it was originally called, or "gallery" or "operating room," as it is more generally termed in America, has, from the first days of photography, received a great amount of attention, and been the subject of much theory and experiment. The earliest illustration of the kind of place used for portraiture in the days of the daguerreotype process is to be found in a drawing by George Cruikshank, which appeared in the *Omnibus* of 1844, and which shows an apparently semicircular room,

With the sitter placed on a high platform at the central point of the diameter to bring him close to the completely glazed roof from which he received a flood of all-round top lighting. Modifications of this form of studio naturally came in with the advent of the wet collodion process, one of the earliest and most notable of these being the original "tunnel" studio, A, of Monk-hoven, so called from the tunnel or unlighted portion in which the camera was placed. The idea of this was partly that the operator might be able to focus without the use of a cloth, and partly that the eye of the sitter, who was still illuminated by strong top front light, might have the pupil less contracted by the latter when he was looking into a dark space. It was also thought that a more "restful" expression would thereby be obtained, but the opposite effect was often produced; and with other improvements, of which the first was the side lighting shown in the diagram, the original tunnel form fell into disuse and is now used for copying only.

One of the first studios constructed with side lighting was that of Col. Stuart Wortley (*see B*). The sloping front light was of clear glass, and that at the side of corrugated glass to 7 ft. from the ground, thence to the roof being of clear glass. It had two sets of blinds, one opaque and one transparent, and was thus the prototype of the modern system of lighting. The next step towards the more modern forms of studio may be said to be the celebrated one of Rejlander, who brought artistic knowledge to bear upon his photographic work, and designed his studio to get the effects he desired. As shown at C, the erection took more the ridge-roofed form, which later came entirely into use; it had side, top, and front lights; all the spaces indicated in the diagram were of clear glass, though those in the gable ends at least were usually covered with semi-transparent blinds, being used to give some amount of diffused lighting on to the shadow side of the sitter. A later studio was that of T. R. Williams (*see D*), and this, having had to be made simply by replacing a solid roof by a glazed one at his premises in Regent Street, London, had an unavoidable south aspect; the difficulties of the direct sunlight illumination were got over partly by working diagonally across the apartment as shown, and partly by the use of no less than three sets of blinds, one over the other, the outer ones being of dark blue calico, the next of thick white calico, and the inner of thin jaconet muslin. In spite of all these difficulties of working, the finest photographic work as regards lighting and modelling, produced up to its date, was done in this studio by its clever user.

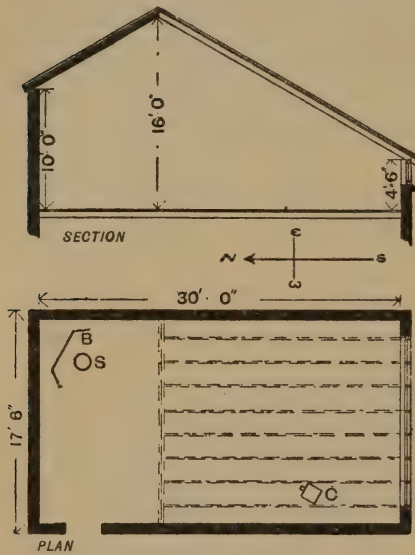
Another later and, indeed, almost modern, south-lit studio was that of Valentine Blanchard (*E*), in which the difficulties of direct sunlight were got over by the use of a movable translucent screen, as shown on the plan and section, and the use of partly obscured glass in the portions indicated by shading in the diagram. Diagrams F to H show the three principal forms of studio now in use. These are drawn in section, and all to the same scale, to facilitate comparison, the glazed portions being shown by thin lines and the opaque portions of the walls and roof by thick ones. In the first place, all three

studios have been drawn to an equal width of 15 ft., but in the "lean-to" and "single slant" types narrower and wider designs have been also respectively indicated to illustrate the greater suitability of the former to narrow studios, and of the latter to wide ones. In the lean-to diagram two roofs of varying pitch are also shown, one at an angle of 30°, and the other at that of 45°, in the latter of which cases it may be noted that the roof becomes rather long and somewhat costly, a defect which, however, might be reduced by making the upper portion a flat, which, in positions in which it is readily accessible, might be utilised for printing, etc. The roof is, of course, shorter in the case of the pitch of 30°, but it then has the disadvantage that snow would lie more easily upon it, and that the incidence of the light upon the sitter is made slightly more vertical than in the case of the steeper roof. This question of pitch also depends largely on the position of the studio and its surroundings, and in these diagrams it has been assumed that the glazed sides of the studios are facing due north, which is, theoretically, the ideal position, though in practice it is generally better to make a studio, if possible, face a little to the east of north, in order that the sun may be off it earlier in the day. The roof pitch is also governed by the fact that the maximum midday altitude of the sun in summer is a little more than 60° above the horizon, and that, therefore, unless the pitch of the roof approaches that angle in steepness, the sun will shine over the ridge into the apartment at that time. This is shown in the diagrams F, G and H by the dotted lines to the left. In the case of a lean-to studio, however, it may be assumed that that form would not be chosen unless there was already some structure in existence for it to be built against, and that it would, therefore, be probably protected from the south, in which case the roof might be kept flatter in pitch. The lean-to form of roof is best suited for studios of from 10 ft. to 15 ft. in width, which are protected by other buildings on the south side, and for which a pitch of 45° for the roof is, therefore, very suitable.

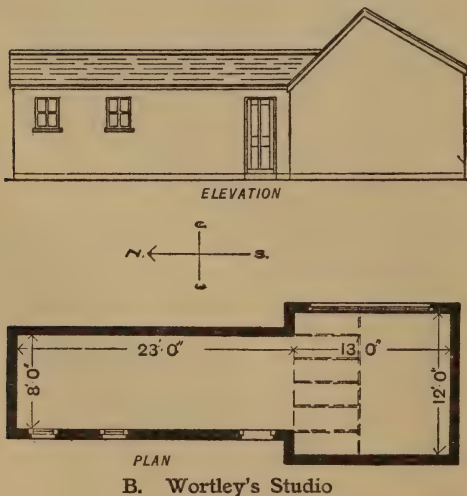
The ridge form has the advantages that it is easy of construction by the ordinary builder; that almost any width can be covered by it; that it gives plenty of headroom for the easy moving about of backgrounds (the square in each diagram represents an 8-ft. stretched background), and that its roof may be made almost of any pitch desired. That in the diagram is at an angle of 45°, in which case, however, unless erected in a sheltered position, it would require a sun-screen on the ridge, at least, at midsummer. By making the slope of the roof 60°, and putting a flat on the top, this could be avoided, and the size of the roof be kept down, but in that case the "single slant" form, as shown in the last diagram, would be preferable. One of the defects of both the lean-to and the ridge forms of a roof is, that as ordinarily constructed, it is frequently necessary to make the wall plate at the eaves of such dimensions that it becomes a positive obstruction to the light, cutting it in two, and so producing a double high-light in the eye of the sitter which has to be either taken out by the use of the knife on the negative or by

that of the brush on the print. In those two forms of studio, also, there is the necessity of having two complete sets of blinds, which when both dark and light ones are used, as is most generally desirable, involves a great complication of cords, wires, and pulleys, to distract the attention of the operator. For these reasons and others, the single slant form of studio has of late

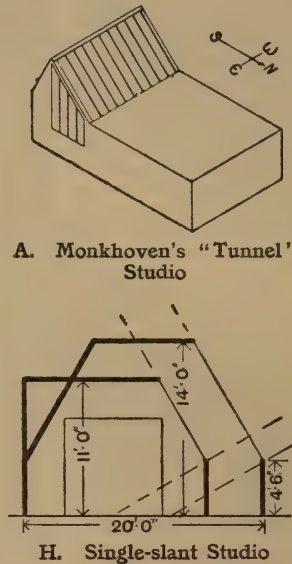
obtained. Of course, like most other things, the single slant studio is not absolutely perfect, it being sometimes not easy to get quite all the top light required, and, unless it is wide enough for one to work across it, it is not altogether a good studio for copying; yet for a fairly wide design, in which case there is also obviously more head room, it is a capital form for general portrait



D. Williams's Studio

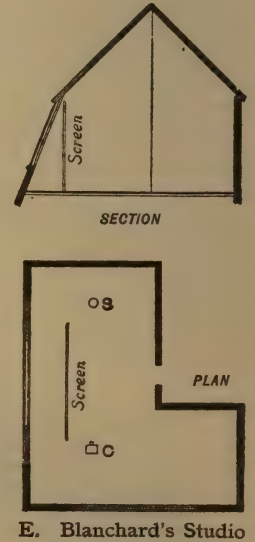


B. Wortley's Studio

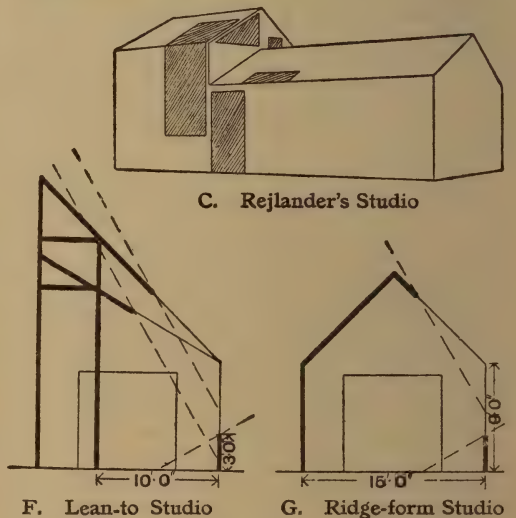


A. Monkhoven's "Tunnel" Studio

H. Single-slant Studio



E. Blanchard's Studio



C. Rejlander's Studio

F. Lean-to Studio

G. Ridge-form Studio

years come more and more into favour, and with it, when roofed to an angle of 60° , the direct rays of the sun are excluded; there is no trouble with snow or leakage; the glass is easily cleaned both inside and out; and with opaque blinds pulling down from the top and up from the bottom, on spring rollers, and a series of transparent ones running on horizontal wires within, all varieties of lighting can be easily

work, and is generally considered the best and most modern form of construction.

With regard to the diagrams F, G and H, it may be noted that the dotted lines to the right enclose between themselves and the base or ground line, an angle which may be subtended by adjacent buildings without the latter obstructing much, if any, of the lighting of the studio itself. In neither of the forms of studio shown



BY (THE LATE) COL. J. GALE

SNOW AND HOAR FROST PHOTOGRAPHY

is it necessary to carry the side lighting down to within less than 3 ft. from the floor, and in most single slant designs 4 ft. 6 in. will be found quite sufficient. Neither in any studio, unless it be very short indeed, is it necessary to carry the side of top light right to the ends, from 3 ft. to 5 ft. at the extremities being preferably built solid to admit of the shading of backgrounds and the getting of a dark atmospheric space behind the sitter when required.

The length of the studio may be anything from 20 ft. to 35 ft., less being too short for the use of ordinary portrait lenses for full length figures, and a greater amount being of not much real practical use. A good amount of width is, however, always an advantage. A very fairly proportioned studio is one in which the width is rather more than half the length. As regards height it must be remembered that all tie rods and similar obstructions must be at least 9 ft. from the ground to allow of the movement of strained backgrounds beneath them; also that as the intensity of light decreases in the ratio of the square of the distance from the source, a very high studio may have a disadvantage in that respect.

The glazed portion of the studio should be executed in one of the many forms of patent glazing without putty which are now on the market. Clear glass is desirable in most positions, as transmitting most light, but if the situation is overlooked, or necessarily of such an aspect as to receive the direct rays of the sun, some kind of obscured glass may be used, the varieties known as rolled and fluted plate being those which stop the least amount of light.

In planning a studio, the entrance doors and those of the dressing-room and dark-room should, if possible, be kept in the unlighted side so as not to interfere with the use of both ends, which may with advantage be fitted up as permanent fixed backgrounds, with plain or papered walls, Lincrusta or other relief work, panelling, tapestry, or whatever form of artistic decoration, suitable for backgrounds, that the taste of the designer may suggest. In the matter of studio decoration generally, light and pleasant tints, such as warm and delicate greys and greens, may be recommended, but heavy and sombre colours should be avoided as absorbing light; strong reds and yellow are unsuitable on account of the non-actinic character of the light reflected from them.

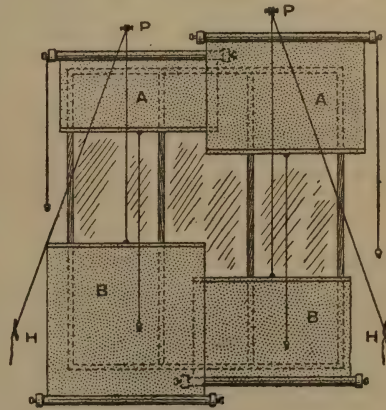
A good smooth floor is, of course, a necessity to facilitate the easy movement of cameras, furniture and backgrounds, and if a stained and polished or parquet floor is not attainable, the best covering for an ordinary one is good inlaid linoleum, on which a few good rugs will produce a pleasing effect.

D. B.

Studio Blinds.—The amount and direction of the light admitted to the studio is usually regulated by means of spring-roller blinds, of dark-blue or dark-green lining. It is advisable to have a double set for all the glazed portion of the studio, overlapping after the manner shown in the illustration. One set, A A, should draw from top to bottom in the ordinary way, while the other, B B, is arranged to pull up from bottom to top by cords passed over pulleys, P P, and carried down again, the free ends being then

fastened to brass hooks, H H. The number of blinds required will depend on the size of the glazed portion, which need not be of very large extent. They should not be too wide, or the lighting will be less under control; about 2 ft. is a convenient width. Where there is a good unobstructed light, white calico blinds are frequently fitted underneath the dark ones, to secure any desired degree of softening. Many workers prefer, instead of this, to have loose white muslin curtains running on wires behind or in front of the dark blinds; while another alternative is to paste white tissue paper on the glass, or to glaze the studio with ground glass. The last two methods have the disadvantage that they may obstruct too much light on dull days. When it is not desired to incur the expense of blinds, dark curtains made to run on wires or rods may be substituted.

Greenhouse as Studio.—Generally, a greenhouse is glazed on two, three, or four sides, and probably down to within 1 ft. or so of the ground, thus admitting light all around the figure. It



Studio Blinds.

is necessary to block out all unnecessary light by gluing Willesden waterproof paper, or similar material, on the inside of the glass. The choice of aspect depends on whether the studio is to be used most frequently in the morning or in the afternoon; if the former, choose a western aspect, and if the latter, an eastern aspect. If the studio is likely to be used at any time, heavy opaque blinds should be provided for each side; or one set of blinds may be made to do duty for either side as required by simply changing over the cord. The opaque blinds and the interior of the studio may be painted a light grey colour. Spring blinds are best for the roof, and two sets will be required, each blind being about 2 ft. across; one set should be of a dark blue (not a green-blue material), and one set of white calico. To regulate the light from the side, dark blue blinds on small brass rings, suspended from a wire, can be used.

STUDIO PORTRAITURE

The chief considerations in portraiture are dealt with under that main heading, but there remain a few special points in studio work that should be mentioned. The conditions of light

ing in a studio allow of numerous effects that are quite impossible in ordinary rooms. The large amount of available light should be controllable by blinds, and when the sitter enters the studio the top light should always be obscured. Otherwise the glare will be found to be too strong for most people, producing a screwing up of the eyes, thus giving a false expression; whereas, by having a subdued light when the model enters, one is able to study features under more normal conditions, and to arrange the pose before letting in bright light. Having attained the desired position, the light is arranged by opening the blinds where required. In this way it is much easier to notice the different effects of light and shade than by having the full amount of light open and gradually cutting it off. The photographer must cultivate the art of making the sitter feel at ease in the studio, it being impossible to obtain a successful portrait if there is a feeling of constraint. Avoid the appearance of all unnecessary appliances; make the studio appear as much like an ordinary room as possible, with interesting pictures, books, plants, etc., to divert the sitter's attention from any idea that he is in some strange place. Have everything ready and at hand that may be required.

STUMPING

The application of powdered colour to a photographic print or enlargement by means of a paper or leather stump, or with a finger-tip, the print being first prepared by rubbing with very fine pumice powder

SUBMARINE PHOTOGRAPHY

This is an application of photography which, probably on account of the very special apparatus, and the great difficulties encountered, has received but little attention. Attempts have been made from time to time, and with varying success, to photograph the bottom of large rock-pools and shallow lagoons, by connecting the camera with a tube of large diameter, pointed downwards through the water. A special raft having a well in its centre, to carry the downward-pointing photographic apparatus, has been used with success; the shadow cast by the raft cuts off all sky reflections. By working at sunrise and an hour or so before sunset, a kind of oblique lighting was obtained which gave very pleasing results, the exposures varying from $\frac{1}{100}$ th of a second to two seconds, according to the depth of water, lighting, etc. Green-sensitive orthochromatic plates were found to yield the best results, the greenish yellow tint, caused by the oblique rays of the sun passing through the sea-water, acting as a kind of natural compensating filter.

The actinic value of light decreases very rapidly with increasing depth of water, so that some means of artificial illumination soon becomes necessary. This at once presents many difficulties, as special apparatus to hold the illuminant becomes necessary, and is rather costly to construct, owing to the perfect fitting necessary to make every part water-tight. Heavy plate glass must be used for the window of the illuminant box, and the box itself must be well weighted to insure its sinking to the bottom on an even keel. The box must be fairly large, so

as to permit of a good sized window, and also a full charge of magnesium powder being used. The best results will be obtained by using two such illuminant boxes, sunk one on each side and slightly in advance of the camera, which also must be enclosed in a water-tight, glass-fronted, weighted box. Both the camera shutter release and the ignition of the magnesium flash can be worked by electrical switches. One trouble which may spoil many exposures is the condensation of moisture on the inner surface of the glass front of the box carrying the camera, due to warm moist air within the box. The glass should be very carefully cleaned, the box kept as cool as possible, and if there is great variation between the temperature of the air and the floor of the sea, a small quantity of calcium chloride may be placed in the box at the moment of closing it. This will be found to act as a preventive of condensation. F. M-D.

SUBSTITUTION PROCESS (See "Ceramic Process.")

SUBSTRATUM (Fr., *Substratum*; Ger., *Unter-guss*)

A solution, generally of gelatine and chrome alum, poured over a plate or other support to cause the sensitive film to adhere to its support. A dilute solution of sodium silicate (1 in 300) has also been used for this purpose, but it is by no means a safe remedy, as its alkaline nature is apt to act on the emulsion. Diluted albumen and a decoction of glasswort (Fr., *Percepièvre*; Ger., *Glaskraut*) have also been suggested. The chrome gelatine solution is prepared as follows:—

Gelatine	37 grs.	4.25 g.
Distilled water to . .	20 oz.	1,000 ccs.

Allow to soak for an hour, melt by the aid of a water bath, and add—

Chrome alum (2% sol.) . .	185 mins.	19 ccs.
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This should be applied freely to the plate, and the latter then set up to drain and dry.

SUGAR IN GELATINE

Ordinary sugar is occasionally added to gelatine solutions, particularly for the carbon process, to render it more soluble and to prevent spontaneous insolubilisation after sensitising. Its action is purely mechanical, as it dissolves out in water.

SUGAR OF LEAD (See "Lead Acetate.")

SUGAR OF MILK

Synonyms, lactose and milk sugar. $C_{12}H_{22}O_{11}$. It is prepared from milk by coagulating the proteid and evaporating the whey to a syrup, when crude sugar of milk will crystallise out; it is then recrystallised, when it forms white rhombic crystals. It is used chiefly in the preparation of dry powder developers.

SULPHIDE TONING

Bromides.—Success depends on the use of a fresh developer for each print, full development, drying after fixing and before toning, and thorough bleaching to a light colour.

Two stock solutions should be prepared, each of which will keep indefinitely.

Bleaching Solution A

Potassium ferricyanide	1 oz.	110 g.
Potassium bromide	1½ "	165 "
Water to	9½ "	925 ccs.

Bleaching Solution B

Mercuric chloride	120 grs.	28 g.
Potassium bromide	120 "	28 "
Water to	10 oz.	1000 ccs.

The table shows the number of parts of these solutions and of water required to produce a variety of tones:—

	Rich brown	Colder brown	Deep brown	Brown-black	Pure black
Bleach. sol. A	1	1	¾	1	½
Bleach. sol. B	—	1	1	2	2
Water	11	10	10½	13	9½

After bleaching thoroughly, the print must be washed; in addition, an acid bath must be used whenever the working solution contains solution B. The acid bath is hydrochloric acid 30 mins., water about 6 oz.; its object is to prevent the combination of the mercury with the gelatine. The print should be taken from the bleaching solution, washed in about three changes of water, and then immersed in the acid solution for two or three minutes. A second and third acid bath should be used, and then the print washed again for about twenty minutes in several changes of water. When the toner for pure black is used for bleaching, the print is intensified considerably, and allowance must be made in printing. There is also a slight strengthening when using the solutions for deep brown and brown-black.

When sufficiently washed after bleaching, the prints should be treated with the sulphide solution. Prepare a stock solution of 520 grs. of sodium sulphide in 10 oz. of boiling water, storing it in a screw-stoppered bottle. The working solution is 40 mins. of the stock solution in sufficient water to make 1 oz. This should be used once, and then thrown away.

Fine red and red-brown tones can be obtained by substituting a stock solution of 1 oz. of sodium sulphantimoniate (Schlippe's salt) and ¼ oz. of sodium carbonate in sufficient water to make 9½ oz.

The prints are bleached in:—

Bleaching solution A	1 part
Water	11 parts

Wash for half an hour, and immerse in one of the following mixtures:—

	Red chalk	Red-brown	Warm brown
Sod. sulphantimoniate sol.	1	2	2
Sodium sulphide sol.	—	½	½
Water	11	24	24

The prints should be washed thoroughly for about half an hour, and then dried. Bleaching solution B—the mercuric solution—must not be used with sodium sulphantimoniate.

P.O.P.—Many attempts have been made to introduce a method of toning *P.O.P.* by the sulphide process, but they have not been sufficiently successful to render the process suitable for ordinary working.

SULPHIDING (See "Sulphide Toning.")**SULPHITE** (Fr., *Sulfite*; Ger., *Sulfit*)

A salt formed by the replacement of the hydrogen in sulphurous acid, H_2SO_3 , by a metal, as, for example, in sodium sulphite, Na_2SO_3 .

SULPHOCYANIDE POISONING

The question as to whether the sulphocyanides of ammonium and sodium are poisonous or not has been a matter of controversy. Dr. Heffter, of Leipzig, in 1896, took several doses of sulphocyanides without feeling any ill effects. On the other hand, it should be said there is the oft-quoted case of a Cambridge lady who, in 1894, was poisoned by taking less than 5 grs., the doctor stating that 3 grs. were sufficient to cause death. Dr. Leo Baekeland stated at the time that "it is a ridiculous mistake to think that the sulphocyanides are poisonous. There is certainly a confusion here with cyanide, which is really one of the most powerful poisons known." In any case, the admission of ammonium sulphocyanide, either by itself or in a gold toning bath, into cuts or sores upon the hand causes much trouble, and it is better in all cases to treat it as if it were a poison.

SULPHO-PYROGALLOL (See "Berkeley's Sulpho-pyrogallol.")**SULPHUR** (Fr., *Soufre*; Ger., *Schwefel*)

Synonym, brimstone. S. Atomic weight, 32. A non-metallic element, occurring native in many parts of the world. It is a brittle solid, lemon-yellow in colour, and tasteless. Solubilities, insoluble in water; soluble in carbon disulphide, turpentine, benzol, and slightly in warm alcohol. The sublimed sulphur (flowers of sulphur) is the purest commercial form.

SULPHUR DIOXIDE (See "Sulphurous Acid.")**SULPHUR TONING**

A method of toning in which free sulphur compounds are used. Bromide prints may be immersed in a hot solution of alum and "hypo," and silver prints, deeply printed, in an acid "hypo" bath. In the second case, the result is fugitive. It will be noted that these are combined toning and fixing methods.

Sulphur toning is frequently an accidental effect. In some forms of the combined toning and fixing baths, if the bath is overworked and the gold becomes exhausted, toning will still continue, the change in colour being due to the deposition of sulphur on the silver image. Sulphur prints are liable to discolour, deteriorate and fade.

SULPHURATED POTASH (See "Potassium Sulphide.")**SULPHURET OF AMMONIA** (See "Ammonium Sulphide.")

SULPHURET OF CARBON (See "Carbon Disulphide.")

SULPHURETTED HYDROGEN (See "Hydrogen Sulphide.")

SULPHURIC ACID (Fr., *Acide sulfurique*; Ger., *Schwefel Säure*)

Synonym, oil of vitriol. H_2SO_4 . A heavy, oily, colourless liquid; specific gravity, 1.84 (= 98 per cent. H_2SO_4 by weight). It is intensely corrosive and chars all organic matter it touches. It is used to acidify some developers, and occasionally with chrome alum as an addition to the "hypo" fixing bath. Great caution is necessary when mixing solutions with sulphuric acid, and the latter should be added slowly to the water, etc., not the water to the acid.

In process work, this acid is not much used, but it forms with potassium bichromate a good pickle for cleaning glass, and with chromic acid a cleaning bath for copper etching, the latter solution being also good for matting a copper plate. In electrotyping, sulphuric acid is largely used in making up the copper depositing bath.

SULPHURIC ETHER (See "Ether.")

SULPHUROUS ACID (Fr., *Acide sulfureux*; Ger., *Schweflige Säure*)

Synonyms, solution of sulphur dioxide or sulphurous anhydride, hydric sulphite. H_2SO_3 , or more correctly, $\text{SO}_2 + \text{H}_2\text{O}$. Solubilities, miscible with water and alcohol. It is a colourless liquid smelling strongly of sulphur dioxide, and containing about 6 per cent. of SO_2 . Molecular weight, 82. It is obtained by deoxidising sulphuric acid with copper or mercury, or by burning pyrites. It is used as a preservative and to acidify the fixing bath.

SULPHUROUS ANHYDRIDE (See "Sulphurous Acid.")

SUN, PHOTOGRAPHING THE

Very little interest attaches to photographs of the sun taken with cameras fitted with lenses of ordinary focal lengths, but good results may be obtained by means of medium or high-power telephoto equipments. If the equivalent focal length is sufficient to give an image about 1 in. or more in diameter, the photographs would probably be of value for scientific records of the phenomena taking place on the sun's surface. In the case of the photographer merely wishing to obtain a chance record, there is no necessity for providing any mounting, or, in fact, any accessories beyond some means of holding the camera steadily in the direction of the sun, and an exposure shutter giving the most rapid exposure it is possible to make. Use any good brand of slow plates, preferably of the fine-grain variety, and develop with a rather hard developer, as in most cases over-exposure will be experienced in spite of the rapid shutter.

If records of more perfect astronomical value are desired, the only difference will be an improvement of the mounting of the camera, to allow of repeated exposures without constant readjust-

ment of the image, and for large-scale work an increase of the aperture and focal length of the lens system employed. In most cases an equatorial mounting will be found necessary, with clock-driven mechanism adjusted to the solar rate of movement. For the telephoto camera, however, either a positive or a negative secondary magnifier may be employed, the actual system chosen depending on the choice of the operator. Both methods are in constant use, and give practically equally good results, although, of course, the positive magnifier makes the apparatus more cumbersome. With such cameras the photographs will show simply the white round disc of the sun, with, at times, groups of dusky spots showing in belts across the middle regions. By means of a special spectroscopic attachment, called the spectroheliograph, it is now possible to screen off all light from the plate, except that of one particular colour, and on photographs thus taken it is found that certain patches of the surface are rendered much more prominent than on the ordinary pictures in integrated sunlight. Instruments of this type are now installed at all the chief observatories of the world.

(For notes on the phenomena to be photographed round the sun on special occasions, see under the headings "Corona Photography," and "Eclipses, Photographing.")

SUNNING-DOWN

Any part of a P.O.P. print that is white or too light and devoid of detail may be toned to a pale grey by sunning-down. A shield is cut and laid over the parts of the print that it is desired to protect, the print being put in a printing frame under a piece of plain glass.

SUNSET EFFECTS

Although the beauty of a sunset effect is so largely dependent on colour, the monochromatic rendering by photography is frequently charming and suggestive. The technical difficulties are, however, often very considerable. The light, although visually brilliant, is more or less non-actinic, and an exposure that is ample for the sky itself is far from sufficient for the rest of the subject. The discrepancy is not so great in the case of the sea as in the case, say, of a wooded landscape, or when there are dark foreground objects. Hence some of the most successful results are those showing the sun setting over the water. As the light at sunset is frequently rich in yellow and red, rather than blue, rays, the use of an orthochromatic plate, or, preferably, a panchromatic plate, is advisable. Under-exposure may produce greater contrasts in the sky, but it deprives the rest of the picture of that subdued luminosity which is one of the charms of sunset.

Sunrises are similar in character and effect to sunsets, but do not receive nearly the same amount of attention from photographers.

SUPER-SATURATED SOLUTIONS

Over-saturated solutions; those overcharged with the salt. A saturated solution of mercuric chloride in plain water may, for example, be made to take up more of the salt by adding hydrochloric acid. The use of such solutions is not recommended in photography.

SUPPLEMENTARY EXPOSURE (See "Auxiliary Exposure.")

SUPPLEMENTARY LENSES

Lenses employed to increase the usefulness of other lenses by altering the focal length. Derogy issued a portrait lens fitted with two supplementary lenses, one being positive and the other negative. J. Traill Taylor developed the idea by fitting a series of lenses upon a slide or wheel which was placed between the lenses of a rapid rectilinear. Later, supplementary lenses were used on many hand cameras to take the place of a focusing adjustment; the Kodak portrait attachment is an example. Achromatised supplementary lenses for portraiture, copying, distant and wide-angle work are sold under the name of "planiscopes." When a lens is set to its infinity focus and a supplementary lens is fitted close in front of it, an object placed at a distance equal to the focal length of the supplementary lens will be sharply defined upon the screen. Thus a spectacle lens of 40 in. focal length will enable an object at that distance to be photographed without focusing or additional camera extension.

SUPPLEMENTARY LIGHTING

Auxiliary exposures have been referred to as supplementary lighting, but the term more correctly refers to the system of casting additional light upon the subject by means of reflectors, mirrors, or magnesium light, in addition to daylight. Magnesium ribbon or powder is largely used for lighting up dark corners of interiors, etc. In interior work, such as crypts, the burning of a few inches of magnesium behind a pillar or other object helps exposure considerably. A mirror can be used in a similar way; it should be held in the path of the sun's rays, which are reflected by the mirror on to the darker parts of the view, the mirror being kept on the move and, of course, out of the field of view. Mirrors are of the greatest service for supplementary lighting when copying in picture galleries.

SWEATING OF THE SCREEN

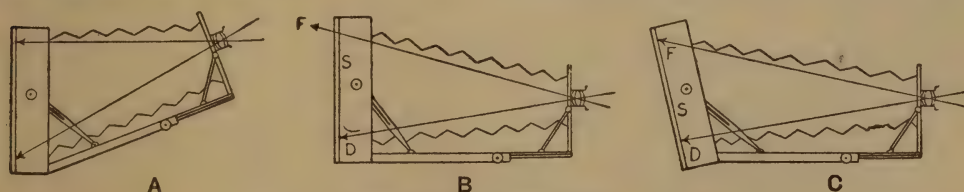
In working the half-tone process with wet collodion or collodion emulsion, especially in winter time, considerable trouble is met with owing to the condensation of moisture on the screen—commonly known as "sweating." The remedy is to warm the screen, or to rub over it a trace of glycerine, or coat it with a thin film of gelatine $\frac{1}{4}$ oz., acetic acid $\frac{1}{4}$ oz., warm water 20 oz.

SWELLED GELATINE PROCESS

Before zinc and copper etching were fully developed this process was largely worked, but it was roundabout and uncertain. A thick glass plate was coated with a thick layer of bichromated gelatine, and after being dried was exposed under a line negative. The plate was then placed in a dish of clean cool water, when the swelling began immediately. The parts of the gelatine film not acted upon by light absorbed water and swelled up. The exposed parts remained at their original level. When the relief was thought to be sufficient, the plate was removed to a hardening bath of chrome alum, citric acid, and water. Whilst still moist, a plaster cast was taken from the gelatine relief, and when this was dry it formed a matrix for a wax mould for electrotyping. If a stereotype was required a second cast had to be made from the first, as the latter was in relief lines, which would have produced an intaglio result in the stereotype. The process is full of difficulty and uncertainty, and the operations take a long time.

SWING BACK (Fr., *Bascule*; Ger., *Bewegliche Visierscheibe*)

An adjustment by means of which the camera back may be inclined towards or away from the lens. The simplest form of swing back is merely hinged at the bottom to the baseboard, but it is preferable to have it pivoted at the centre. The swing back is used when the camera has to be tilted to include the top of a high building. In such a case, the upright lines of the building would be shown converging towards the top, as



Use of the Swing Back

SUTTON, THOMAS

Died, 1875. An active photographic experimenter from 1856 to 1872. Founder and editor of *Photographic Notes*, and the inventor of a panoramic camera. In 1862 he invented a plan for giving paper a coating of indiarubber dissolved in benzole, before albumenising. In 1859 he invented a fluid lens.

SWANTYPE

A half-tone process devised by J. W. Swan, and differing from the ordinary half-tone process only in the manipulation of screens and stops.

if the building were falling over backwards. By bringing the swing back into operation, as at A, so that the focusing screen is parallel with the building, the lines are rendered vertical. The tilting of the lens with regard to the plate necessitates the use of a small stop, and it is better to avoid inclining the camera if the same result can be obtained by using the rising front. Another employment of the swing back is when objects at different distances are required to be equally sharp without stopping-down, as, for instance, the knees and hands as well as the head of a sitter in portraiture, or the foreground

and middle distance of a landscape. Near objects are always brought to a focus farther from the lens than distant ones, as shown at B, where the foreground of the picture is seen to be focused at F, beyond the position of the ground-glass screen S, when the distance D is sharp, while if the near foreground is in good definition the distance is thrown out of focus. By inclining the swing back outwards, as at C, both foreground and distance are in focus at once. This method of equalising the focus must be used cautiously, as it has the defect of introducing a slight distortion. Some cameras are provided also with a side-swing, the camera being then said to have a double swing back.

SWING FRONT (Fr., *Planchette à bascule*; Ger., *Bewegliches Objektivbrett*)

An adjustment in which the camera front is hinged to the baseboard frame, or is pivoted at its own centre, so that the lens may be swung upward, or downward. The principal advantage is that high buildings may be included on the plate without having to tilt the camera. It is necessary to keep the back vertical, and some stopping-down of the lens is usually required, for which reason it is preferable whenever possible to employ the rising front movement instead, as this enables the lens to be used at a larger aperture. The use of the swing front has the same effect as that obtained by tilting the camera and using the swing back, but the lens is not so easily kept with its axis falling on the middle of the plate. Many field cameras have a swing adjustment to both back and front.

SYMBOLS (See "Element" and "Solubilities.")

SYMMETRICAL LENS

A lens in which the two combinations have similar curves and balance one another.

SYMPATHETIC PHOTOGRAPHS

A plain piece of paper is coated with a 10 per cent. solution of gelatine, dried, floated upon a 10 per cent. solution of potassium bichromate, and dried in the dark. The paper is exposed under a positive, say an unmounted lantern slide. The print, with the image showing very faintly, is then immersed in a 10 per cent. solution of cobalt chloride, when the parts not acted upon by light will absorb the solution. The print is then washed and dried. A faint image will be seen, and this will change colour according to the condition of the atmosphere. When the weather is fine and dry or heat is applied to the print, the picture will be of a pretty blue colour, but when damp the colour will change and the picture almost disappear. (See also "Barometer, Photographic.")

By the Stone method the image is composed, as above, of gelatine rendered insoluble upon unsized paper; when the paper is dipped in water the image appears by reason of those portions of the picture having no gelatine upon them becoming comparatively transparent; as the picture dries the image disappears. Stone's sensitive solution was: Water, 5 oz.; gelatine, $\frac{1}{4}$ oz.; potassium bichromate, 24 grs. Unsized paper was coated with this

(warm), dried in the dark, printed under a negative, and soaked in warm water.

SYNCHROMIE

A four-colour printing process in which all the colours are printed at one impression, invented by Vittorio Turati, of Milan. A mosaic of pigment colour was formed on the bed of the printing machine, and, the surface being damped, impressions were taken off on to paper.

SYNTHETIC GUM (See "Arabin Gum-bichromate Process.")

SYNTHOL

A trade name for a developer in powder form, a hydrochloride of diamido-orscinol. $C_6H(CH_3)(OH_2)(NH_2HCl)_{21}$. It is said to be obtained from various plants, the mother substance being orscin. It is very soluble in water and can be used in conjunction with sodium sulphite without an alkali, like amidol. A working formula is:—

Sodium sulphite . . .	300 grs.	68 g.
Potassium bromide . . .	5 "	1.1 "
Synthol . . .	30 "	6.8 "
Water . . .	10 oz.	1,000 ccs.

SYPHON (Fr., *Siphon*; Ger., *Heber*, *Siphon*)

An appliance for drawing off water or other liquid from a vessel without disturbing the latter. A simple syphon may be made with a bent lead pipe, one end of which is longer than the other. The short arm is corked and the tube filled with water, the long arm being then also corked. The short end of the pipe is introduced in the vessel and the cork removed; then on taking out the other cork the syphon will commence to work, the liquid in the vessel rising up the tube and discharging. Another convenient device is a short length of rubber tubing with spring clips for the ends. Some syphons are provided with an additional tube joined near the end of the long arm; by its means, the liquid is drawn over the bend by suction.

SZCZEPANIK'S PHOTO-WEAVING PROCESS

Jan Szczepanik invented an ingenious method of producing the cards for the Jacquard loom by photographic means. His method is based on the half-tone process, and consisted in the use of a series of special ruled screens and variously shaped diaphragms which produced a negative in square dots something like a design for crewl work. This negative was printed by means of sensitised fish-glue on to a zinc plate, the image being developed, so that the dots were isolated, with spaces of bare zinc around them, and in some parts there were no dots at all, as the light and shade of the picture demanded. The plate was then put into an electrical apparatus, so arranged that a tracer point passed in lines over the plate, the point alternately making and breaking contact as it passed from the enamel film dot to bare metal. Thus an electrical current was intermittently transmitted to a Jacquard punching machine, the keys of which were operated by the current.

T

TABLET CRUSHER

An appliance for pulverising "tabloid" and other compressed chemicals, and consisting of a round metal receptacle, in which fits a peculiar form of stopper which may be used as a pestle. The "tabloid" is placed in the receptacle and reduced to powder by working the stopper.

"TABLOIDS"

A proprietary name (registered in 1884) for compressed chemicals made by the successors of Brockendon, who, in 1842, originated compressed chemicals in the shape of bi-convex discs. They contain chemicals in correct and known quantities, and need simply to be dissolved in the required amount of water to make a working solution. There are many other forms and makes of compressed chemicals.

TACHYSCOPE (Fr., *Tachyscope*; Ger., *Tachyskop*)

A form of zoëtrope invented by Ottomar Anschütz, of Lissa, and used to reconstruct the appearance of motion from animal photographs taken in series. It consisted of a shallow cylinder into which a bent strip of photographs was inserted. The strip was pierced with upright narrow slits between the photographs, the number of slits corresponding with that of the pictures. The advantage was that a variable number of photographs might be used to form a series, whereas with the zoëtrope the number must always correspond with the slits in the fixed side. Anschütz also invented an electrical tachyscope.

TALBOT, HENRY FOX

Born 1800, died September 17, 1877. Retired from public life in 1834 to devote his whole time to scientific work. While sketching at Lake Como with Wollaston's camera lucida in October, 1833, he was struck with the idea of fixing images produced by that instrument, and six years of steady work at the problem followed. He was to some extent successful, and on January 31, 1839, he read before the Royal Society a paper on the process, which he called "Photogenic Drawing"; this paper was afterwards published in the *Philosophical Magazine*. Prof. Faraday exhibited at the Royal Institution on January 25, 1839, a collection of Fox Talbot's "photogenic drawings," which were produced solely by the action of light, and at the same time described the process (*which see*, under the heading "Photogenic Drawing"). Daguerre was experimenting at the same time, and published his results in 1839, but the methods of the two men were different, that of Fox Talbot giving an image on paper, whereas that of Daguerre produced an image upon a polished silver surface. The calotype process, often

called the talbotype process, was patented by Fox Talbot on February 8, 1841, and was the subject of the third British photographic patent. Fox Talbot in 1843 patented the use of a hot solution of sodium hyposulphite for making the pictures of his process whiter and more permanent; Sir John Herschel had suggested it in 1819, and again advocated its use in 1843. In 1843 Fox Talbot took his process to Paris, and in the following year (1844) began to publish his famous work "The Pencil of Nature." After the introduction of the Archer collodion process in 1851, he devised a modification of it by which shorter exposures were possible. A year later he invented a process of engraving upon steel plates by means of photography, and in 1854 he introduced albumen to give a gloss to the surface of paper on which photographs were printed. The calotype (or talbotype) process of making negatives upon paper was largely used by amateurs of the period, it being less costly and troublesome than the daguerreotype process, which was preferred by the professional portraitists.

Talbot was the first to describe the use of line and network screens for the purpose of breaking up the image into dots, and for this purpose he made use of crêpe, silk gauze, muslin, and lines ruled on glass. He did not realise, however, the idea of optical formation of the dot in the negative as now practised.

TALBOTYPE (See "Calotype, or Talbotype, Process.")

TALC (See "Chalk, French.")

TANK DEVELOPMENT (See "Development, Stand.")

TANK, WASHING (See "Washing Tank.")

TANNIC ACID (See "Tannin.")

TANNIN (Fr., *Acide tannique*; Ger., *Gerb-säure*, *Gerbstoff*, *Tannin*)

Synonym, tannic or digallic acid. $C_{14}H_{10}O_9$. Molecular weight, 322. Solubilities, 1 in 1 water, 1 in .6 alcohol. A lustrous, faintly yellow amorphous powder extracted from gall nuts and all kinds of bark. It has been recommended as a hardening agent for prints, but it forms an insoluble compound with gelatine which darkens in light.

In process work, tannin is sometimes used as an ingredient in the etching solution for collotype plates, with the object of hardening the gelatine film. A strong solution is sometimes applied locally to make certain parts take the ink. It has also been used for writing titles and other lettering on collotype plates, the parts to which

the tannin ink was applied printing black. The addition of tannin to the chromated gelatine before coating the plate has been recommended for making the film more durable and lasting.

TANNIN PROCESS (Fr., *Procédé tannin*, *Procédé Russell*; Ger., *Tannin Prozess*)

A dry collodion process invented by Major Russell, in which a preservative bath of tannin was used. The plate was coated with a substratum of gelatine and then with iodised collodion, after which it was sensitised for five minutes in a silver nitrate bath, and then well washed. The preservative was a filtered solution of 15 grs. of tannin to each ounce of distilled water. This was poured on and off the plate several times, throwing away the first portion, the plate being then stood up to dry in the dark-room. Plates prepared in this way were ready for use when dry, and would keep some time.

TANNING PRINTS

Tannin has been recommended for hardening gelatine negatives and prints, a typical formula being:—

Tannin	4½ grs.	1 g.
Sodium chloride	45 "	10 "
Alum (saturated sol.)	405 mins.	85 ccs.
Water	10 oz.	1,000 "

The tannin and sodium chloride (common salt) are first dissolved, and the saturated alum solution added, the mixture being filtered or decanted. The prints are immersed for a few minutes and well washed. It has been stated that prints hardened with tannin become yellow after a time; whether this is so or not, the method has no advantage over the use of formaline or chrome alum. (See also "Hardeners" and "Fixing-hardening Baths.")

TARTAR, SALT OF (See "Potassium Carbonate.")

TARTARIC ACID (Fr., *Acide tartarique*; Ger., *Weinsäure*)

$C_4H_6O_6$ or $(CH_2)_2(OH)_2(COOH)_2$. Molecular weight, 150. Solubilities, 1 in .75 water, 1 in 3 alcohol, 1 in 250 ether. It is in the form of colourless transparent rhombic crystals obtained from argol or crude potassium bitartrate, deposited during the fermentation of wines. It is used as a preservative for sensitised papers and in printing-od emulsions.

TAUPENOT'S PROCESS

A collodio-albumen process invented in 1855 by Dr. J. M. Taupenot, a French scientist. It was largely used for the production of stereoscopic transparencies, and was a rival process to the albumen process used by Ferrier, the details of the latter being kept secret.

TAYLOR, J. TRAILL

Born 1827; died 1895. An authority on photographic optics and editor of the *British Journal of Photography* from 1864 to 1879 and 1886 until his death. He was a watchmaker by trade, but as a youth practised the daguerreotype process, and during his long residence in Edin-

burgh came into contact with Brewster, Fox Talbot, Ponton, and many other photographic and scientific celebrities. His first association with photographic journalism was in 1856. In 1860 he delivered a lecture before the Royal Scottish Society of Arts on "The Use of the Optical Lantern in Photography," on which occasion photographic lantern slides were publicly exhibited for the first time. Between 1880 and 1885 he edited an American photographic journal, the *Photographic Times*.

TEA PROCESS

In an obsolete process tea was used as a preservative or organifier for collodion plates. For other preservatives, see "Coffee Process."

TEA-TRAY LANDSCAPES

Landscapes built up in a miniature form upon a tea-tray, a branch of work with which the names of Newton Gibson and W. Perry Barringer are connected. Snowscapes and desert scenes are the easiest to produce, sugar, flour and sand being used to build up the scenes. Trees may be made out of small sprigs of foliage, asparagus, etc., and miniature china figures, animals, etc., included. Properly lighted and skilfully photographed, effective pictures may be produced in this way.

TELAUTOGRAPH (See "Photo-telegraphy.")

TELECTROGRAPH (See "Photo-telegraphy.")

TELECTROSCOPE

An early form of instrument for the electrical transmission of photographs; invented by Szczepanik and Kleinberg, in 1898.

TELEGRAPH, PHOTOGRAPHS BY (See "Photo-telegraphy.")

TELEMETER (See "Distance Meter.")

TELEPHOTO LENS (Fr., *Lentille téléphotographique*; Ger., *Teleobjektiv*)

A lens giving a high magnification compared with ordinary lenses used with the same extension of camera. The earliest commercial telephoto lens was made by Thomas R. Dallmeyer in 1891, and consisted of a single positive lens, somewhat like a telescope object glass, and a triple cemented negative lens of high power. In consequence of the low intensity and high magnification thus obtained, the telephoto lens was suitable only for a very limited class of subjects, and it was not until a moderate power combination with a maximum intensity of about $f/9$ was introduced that telephotography became general. Negative attachments for use with existing rectilinears and anastigmats were then issued, and finally the Adon lens, a complete telephoto lens of small size and weight, removed the last difficulties connected with this branch of work. Excellent telephoto lenses are now made by a number of makers. (See also "Telephotography" and "Bis-telar.")

TELEPHOTOGRAPHY (Fr., *Téléphotographie*)

The photography of distant objects by means of lenses giving high magnification compared

with ordinary lenses used with the same extension of the camera. A telephoto lens is, in fact, a long-focus lens requiring but a short camera extension; it has not a definite or fixed focal length like other lenses, and it may be so adjusted as to give a sharp image at any extension of the camera, provided that the extension is not less than the focus of the positive lens which forms part of the telephoto lens.

The combination of lenses which forms the telephoto system consists of an ordinary photographic lens, preferably a rapid anastigmat, called the positive element; and a negative lens, so arranged that its distance from the positive lens may be varied by means of a rack and pinion on the lens mount. The distance from the positive to the negative element and the distance from the negative lens to the sensitive plate are variable, the former being determined by the latter, and on these distances depends the degree of magnification; or, in other words, the proportionate size of the image compared with the size of the image yielded by the positive lens alone.

Unless the positive lens can work at $f/8$, focusing and the arrangement of the picture become very difficult. The value of the aperture of the positive lens is reduced by the negative element in direct proportion to the magnification; consequently, with a magnification of four times, $f/8$ becomes $f/32$.

For ordinary work, the focus of the negative lens should be about half that of the positive. If great magnification is required for special work, the focus of the negative lens should be still less. This short-focus negative lens has the disadvantage of reducing the covering power of the positive lens, and this is a serious but unavoidable objection to the telephoto lens system.

Although the focal length is lengthened, the area covered by the lens is reduced very considerably; but, with a given combination of lenses, the greater the magnification, the greater will be the covering power. It is very desirable that the focus of the negative element should be known, as it provides a definite basis for ascertaining the degree of magnification. Ernest Marriage gives the following simple rule for finding the magnification when the focus of the negative lens is known: After focusing, divide the distance from the negative lens to the focusing screen by the focus of the negative element, and add 1 to the result. *Example.*—A negative lens of 4 in. focal length is used, and, when the image is sharply focused, the negative lens is 8 in. distant from the focusing screen. What is the degree of magnification?

$$\frac{8}{4} = 2; 2 + 1 = 3 \text{ times.}$$

Many telephoto lenses have a scale of magnifications engraved on the mount, so that, when the image is sharply focused, the degree of magnification can be read off from the position of the indicator on the scale.

The working value of the stop can be ascertained by multiplying the value of the aperture in the positive lens by the degree of magnification. Thus, with a magnification of three diameters, $f/8$ becomes $f/24$; and with a magnification of four times, $f/11.3$ becomes about $f/45$.

The size of the image increases with the extension of the camera, so that it is a very simple matter to secure any size that may be desired. If the image when first focused is too small, the extension of the camera should be increased, and then the subject re-focused by the rack and pinion on the lens mount. If it is too large, decrease the camera extension and re-focus.

Attention has been directed to the fact that the covering capacity of the telephoto lens is very small; consequently, the use of the rising front becomes an impossibility, as the plate would show dark corners. Tilting the camera is necessary for all subjects which would require the rising front when using an ordinary lens; and when the tilting becomes excessive, as in photographing architectural details at a considerable height from the ground, it is not practicable to set the camera back vertical owing to the impossibility of securing good definition throughout when the plate is at such an angle to the axis of the lens.

An objection to many telephotographs is the very slight perspective effect obtained. It is the extreme opposite to the exaggerated effect sometimes produced by a wide-angle lens, but at times it is quite as pronounced and as unnatural.

Two difficulties that become serious when working with a telephoto lens for distant subjects are haziness in the atmosphere, which renders it impossible to secure clear detail, and wind, even a slight breeze introducing serious vibration with the long camera extension.

TELEPHOTOSCOPY OR TELE-ELECTROSCOPY (See "Photo-telegraphy.")

TELESCOPIC TRIPOD (See "Camera Stand.")

TEMPERATURES

Most of the solutions for ordinary photographic work should be used at a temperature of 65° F. (18° C.), or as near that as possible. Solutions for developing and fixing negatives and bromide prints, toning and fixing silver prints, toning bromide prints, and intensifying and reducing, should all be kept as nearly as possible to this standard temperature. In cold weather the dishes should be warmed before beginning any operation. The developing solution for cold-bath platinotype should not be used cooler than 65° F. or warmer than 90° F. (32° C.). The standard temperature for developing carbon prints is from 100° to 110° F. (38° to 43° C.).

The temperature of developers influences the time of development considerably. A normal Azol solution, for example, will, with a given plate and used at a temperature of 40° , develop a plate in 21 minutes, whereas if used at 90° development would be complete in $3\frac{1}{2}$ minutes. The intermediate temperatures and times are:— 45° , $17\frac{1}{2}$ min.; 50° , 14 min.; 55° , $12\frac{1}{2}$ min.; 60° , $10\frac{1}{2}$ min.; 65° , $8\frac{1}{2}$ min.; 70° , 7 min.; 75° , 6 min.; 80° , $5\frac{1}{2}$ min.; and 85° , $4\frac{1}{2}$ min.

Developer, fixer, and washing water should be of practically the same temperature, more particularly when bromide paper is used; otherwise blisters and other troubles may occur. If such is not possible, the change should be gradual.

TEMPORARY SUPPORT

This is used in carbon printing for the double transfer process; known also as a "flexible support." Its purpose is to hold the carbon film during development, etc., until ready for the second transfer to the final support. The flexible temporary support is a paper coated with a mixture of lac and gelatine that has been rendered quite insoluble; and, after coating, the paper is rolled under heavy pressure, so as to present a fine, smooth, and semi-glossy surface. The temporary support is prepared for use by rubbing over with a waxing solution (white wax dissolved in turpentine); after allowing two or three hours for the turpentine to evaporate, the support is ready for use in exactly the same manner as single transfer paper. After the flexible support has been soaked for a few minutes in water, the exposed print is squeegeed to the prepared surface; and after development, washing and drying, a piece of double transfer paper is squeegeed to the print. When thoroughly dry, the double transfer paper holding the film firmly may be pulled away from the temporary support, the surface of which is left quite clean. Before using again the flexible temporary support requires re-waxing. When using this support a longer immersion in the alum bath is necessary than for ordinary single transfer paper.

In addition to the flexible temporary support commonly used in the carbon process, a piece of matt-surfaced opal glass is sometimes used when it is desired to obtain prints with a matt surface instead of the semi-gloss imparted by the flexible paper support. This opal glass is prepared by waxing, and it is used in exactly the same manner as the flexible support.

TENT, DEVELOPING (See "Developing Tent.")

TEREBENTHENE

A rarely used synonym for turpentine.

TERTIARY COLOURS (Fr., *Couleurs tertiaires*; Ger., *Tertiäre Farben*)

A term usually applied to colours saddened or lowered in luminosity by the admixture of black or grey.

TERTIARY SPECTRUM (Fr., *Spectre tertiaire*; Ger., *Tertiäre Spektrum*)

The small residual colours of the spectrum left outstanding when the secondary spectrum is corrected in lenses. That is to say, an ordinary lens is corrected for two colours, and the outstanding spectrum is known as the secondary spectrum; if three colours are corrected, the outstanding spectrum is known as the tertiary spectrum.

TEST PAPER (Fr., *Papier réactif*; Ger., *Reagens Papier*)

Bibulous paper immersed in various solutions and dried, used for testing the acidity or alkalinity, etc., of liquids. Various kinds, such as azolitmin, brazilin, congo red, dahlia, hæmatoxylin, etc., are used by chemists, but those principally used by photographers are litmus, methyl orange, phenol-phthalein, and cochineal.

The following table gives the resultant colours in the various solutions:—

	Acid	Alkaline	In the presence of carbon dioxide (carbonic acid)
Cochineal .	Yellow . .	Reddish violet	Not affected
Litmus . .	Bright red .	Blue . . .	Reddish purple
Methyl orange	Red . . .	Yellow-brown	Not affected
Phenol-phthalein . . .	Colourless .	Intense red .	Useless

TEXTILES, PHOTOGRAPHS ON (See "Fabrics, Printing on.")

TEXTURE (Fr., *Tissure*; Ger., *Gefüge, Textur*)

The natural depiction of different surfaces or materials in a photograph, which is then said to have good textures, or textural rendering.

THAMES COLOUR PLATE

A screen-plate patented by C. L. Finlay, in 1906, and consisting of contiguous red and green circles with blue-violet interspaces, so small that there are 70,000 colour patches to the square inch. It is supplied either coated with an emulsion or for use with separate panchromatic plates. A compensating yellow filter of stained gelatine is inserted between the lens combinations, and the plate, loaded in darkness, is exposed glass side to the lens. It is developed in darkness for exactly five minutes in ordinary temperature, using hydroquinone with caustic potash. The plate is then washed for one minute and placed in the reversing solution: Potassium bichromate, 1 oz., or 80 ccs.; water, 10 oz., or 800 ccs., sulphuric acid, 1 drm., or 10 ccs. After a few seconds, the dish is taken into daylight and watched until a positive is seen on holding the plate up to the light. After well washing under the tap, the plate is re-developed till a little denser than required, washed for one minute, and fixed in "hypo," finally washing well, and when dry binding up with a cover-glass. If separate plates and screens are used, the plate is developed by itself, afterwards registering with the screen.

THEATRICAL AND KINEMATOGRAPH PHOTOGRAPHY

Theatrical Photography.—The usual plan of taking photographs in a theatre is to employ flashlight, elaborate arrangements and a large battery of lamps, combined with the usual stage lights, being necessary in most cases. The invention, in 1901, of the Grün fluid lens, working at an aperture of $f/2.5$, enabled well-exposed negatives of stage scenes during a performance to be obtained in one-quarter of a second's exposure, and pictures of actresses, etc., in their dressing-rooms, with five seconds' exposure. Under very favourable circumstances even shorter exposures were given; at the London Alhambra, for example, excellently exposed negatives were taken from the stalls with an exposure of $\frac{1}{25}$ second without the knowledge of the performers. Rapid but not specially prepared plates were used in conjunction with the

Grün lens. Arthur Payne considers that no "ordinary" plate, however fast, can equal for such work, by artificial light, a plate specially bathed in the manner described below. The speed of these special plates varies from 500 to 550 H. and D. According to Arthur Payne's article in the *British Journal of Photography* (July 6, 1906), clean working plates of medium speed were bathed in the following:—A stock solution of orthochrom T dye is made by dissolving 1 g. in 1,000 ccs. of alcohol (90 per cent.), and 4 ccs. of this, together with 3 ccs. of liquor ammoniæ, are added to 200 ccs. of distilled water. This solution is filtered and used at a temperature of 60° to 65° F. (15.5° to 18° C.). It must be made up as required, as it can be used only once. The plates are immersed for three minutes, care being taken to rock the dish and avoid air-bells. The solution is then poured away and the plates washed in running water for three minutes and dried. The plates are now extremely sensitive to yellowish light, and therefore the bathing, washing, and drying must be carried out in darkness or in the safest of ruby lights. The plates should be used as soon as possible after they are dry. The development of these plates is as usual, except that it is best to use the developer at a temperature of about 75° F. (about 24° C.). Most of the organic developers probably give equally good results with these plates, but bromide or other restrainer must not be used, and they must be of maximum strength, so that when used a slight fog appears over the whole of the plate. Edinol is found to give one of the best kinds of negatives, fairly free from grain, which will bear enlarging up to five or six diameters.

The plates treated as described above were used with success by many workers, but Mr. Payne discovered later that a 1 in 50,000 solution of pinacyanol, used instead of orthochrom T, gave increased sensitiveness and made the plates more sensitive to red than to blue. The gain in speed by yellow light is considerable when pinacyanol is used; indeed, when a stage is illuminated by yellow light, only focal plane shutter exposures of $\frac{1}{4}$ to $\frac{1}{15}$ second are possible with a lens working at $f/3$. In manipulating the plates, darkness is best, or a very weak green "safe" light.

In the majority of cases negatives of theatrical photographs will be found very thin, although possibly full of detail. Dr. Grün advocated intensification with uranium, but Arthur Payne advises printing upon gaslight paper, or the making of a contrasty transparency upon a photo-mechanical plate in the camera, enlarging the image about two diameters, and from this positive making an enlarged negative in the camera; by obtaining as much contrast as possible in the enlarged negative and printing upon gaslight paper, the contrast in the final print will probably be all that is required.

Photographically, stage lighting may be divided into two classes: diffused lighting, when the whole of the stage is fairly equally flooded with light; and focused arc lamps or lime lights when the light is concentrated upon one part of the stage or upon the principal actor in the scene. These effects are used independently and together, and the photographer should try to

select a moment when the subject is illuminated by both focused and diffused lighting; although the strong, bright lighting resulting from the use of focused arcs alone produces interesting effects, which photograph easily and well. Occasionally some pretty effects may be obtained from the wings on the stage, more especially when the figure is lit by focused arcs, but permission to use a camera in the wings during a performance is rarely given. Arthur Payne believes that the best position to work from, on the stage itself, is obtained by sitting upon a chair, this resulting in a low point of view, on the O.P. side of the stage—that is, on the right-hand side as the audience see it. The reason for selecting this side is to avoid obstructing the officials, who are generally on the "prompt" side in the execution of their duties. The stage appears to be brighter, by contrast with the darkened theatre, than is actually the case, but Mr. Payne says this difficulty may be overcome by observing the amount of light which is reflected from the stage into the auditorium; in this manner fluctuations in the light may be followed with ease. It may be accepted as a general rule that the longest possible exposure should be given on all occasions, for it is unlikely that the photographer will ever meet with over-exposure, except under extreme conditions, as stage lighting usually gives heavy shadows.

Kinematograph Photography.—This involves similar lighting conditions to those necessary in ordinary photography. Excepting in the case of stage scenes and "make-ups," the operator of the kinematograph camera does not know many moments in advance what is going to happen next. A crowd of people may, perchance, unconsciously group themselves into a most desirable arrangement, but the chances are they will not. An elevated position should be chosen, so that possible obstructions, such as people passing close to the lens, and, therefore, out of focus, are avoided. The direction of the light, especially at noon, should be oblique and coming from the back of the operator, either from his right or left; direct front lighting should be avoided. Ideal illumination occurs when the sky is thinly overcast, with plenty of light sifting through the clouds. Critical definition, a full range of tone values, and exact speed with even motion, are the three chief points to be aimed at. The first point relates to choice and management of the lens and the adjustment of the shutter aperture; the second relates to the light and afterwards to proper development; and the third to the correct operating of the mechanism. The handle must be turned at the rate of two revolutions per second, and its speed must be regular throughout the operation, irrespective of all else.

"Make-ups" and stage subjects afford opportunities of arrangements not possible with topical or street scenes. The questions of lighting and optical conditions remain the same. Stages on which motion-picture plots are executed are generally on the tops of houses, so that as the sun alters its position, there are no shadows of surrounding buildings cast upon the scene; but the house-top studio is not to be preferred to a good open space on the ground level. The professional's stage is built on the revolving principle, so that the direction of the lighting can be kept

constant throughout the day. The amateur is not likely to want to take more than two or three subjects in one day, and these he can arrange for when the lighting is at its best.

When the camera has been set up on a rock-steady support, the field covered by the lens should be marked out on the floor of the stage by means of white tape or chalk lines, as an indication to the actors. The time limit for the actions in each section is arrived at by rehearsing the play, whilst the operator turns the handle of his machine at the recognised speed; the camera need not be loaded, providing it is fitted with a speed-indicator. It is the work of the stage manager to watch the acting and to decide upon the question of elimination. All superfluous action is cut out, not only to reduce expense, but to crystallise the plot. No action is introduced that can be assumed to happen, and only such natural motions are allowed as will render the subject intelligible to the average mind.

Trick and Make-up Subjects.—Motion-picture photography lends itself to trickery and make-believe more than any other branch of the picture-making art. In subjects where human beings are represented as passing through great peril, the stop-camera method is resorted to. Thus, an actual person acts the part up to the safe stage; the camera is then stopped, and a dummy substitute provided, made up to represent the original. In like manner, when inanimate objects are made to move without apparent human control—such, for instance, as a knife cutting by itself a loaf of bread; cups and saucers collecting themselves into a heap; and so on—the photographer takes one or two pictures, stops, the articles are moved to the second position in their progress of movement, the camera again operated for the space of one or two pictures and again stopped, the articles moved to their third position, and so on through the entire series of pictures. The process naturally takes a long time to accomplish, but the results are often well worth the trouble expended. Some cameras are fitted with means whereby the operator may ensure exposing only one picture space at a time, and an assistant generally carries out the work of altering the positions of the objects after each exposure. If a camera has its shutter aperture so adjusted that sufficient exposure is obtained whilst operating at less than the normal speed of sixteen exposures per second, a subject moving normally will appear to be moving swiftly when projected upon the screen; the opposite holds good when the camera is operated abnormally quick.

Stationary subjects, such as a man's face, may be represented as increasing in magnitude by causing the camera to travel towards the subject during operation. Likewise, diminution of objects may be produced by taking the camera away from the subject during operation. This diminishing and growing magnitude effect incidentally creates the illusion of an approaching or receding subject. Hence, a train represented on the screen as approaching, appears by its ever-increasing size, to rush almost off the sheet into the auditorium.

To give the effect of a balloon rising or falling, or a flying machine travelling in space, rollable backgrounds, on which are depicted distant land

and clouds, are placed behind the scene and operated. The rollers on which such backgrounds are wound are fitted to supports capable of universal movement in one plane. If a balloon or any other object is to be represented as ascending, the background is wound from top roller to bottom, passing downwards, or in an opposite direction to that in which the balloon is supposed to be moving. If a flying machine is represented as travelling from left to right, the background is moved in panoramic order from right to left.

Many other effects are produced by what is known as composite printing, in which process masking is resorted to and the print made by exposure in contact with two, three or more separate negative films in succession, according to the complexity of the subject to be produced.

Dissolving effects are produced as described under the heading "Dissolving-views." Under the heading "Aerial Screen" is explained one method of producing "ghost effects" in kinematography.

THEATROGRAPH

A lantern projection apparatus for displaying a series of photographic pictures, invented by R. W. Paul, in 1896.

THERMO DEVELOPMENT (See "Development, Thermo.")

THERMOMETER

A temperature measurer; there are three thermometer systems in more or less common use, namely, Fahrenheit, Réaumur and Celsius, the latter being best known as Centigrade. The Fahrenheit system, invented in 1714, is the most widely used in England; the Centigrade system, invented in 1740, abroad; while the Réaumur system, invented 1731, was in use in Russia. It is a simple matter to convert one to another. To convert—

Centigrade into Fahrenheit, multiply by 9, divide by 5, and add 32;

Fahrenheit into Centigrade, subtract 32, multiply by 5, and divide by 9;

Centigrade into Réaumur, multiply by 4 and divide by 5;

Réaumur into Centigrade, multiply by 5 and divide by 4;

Fahrenheit into Réaumur, subtract 32, multiply by 4, and divide by 9;

Réaumur into Fahrenheit, multiply by 9, divide by 4, and add 32.

THERMO REGULATOR (See "Mercury Thermo Regulator.")

THINNING SOLUTION

A mixture of equal parts of ether and alcohol used for thinning collodion which has become thickened by evaporation, or which has been made up with too great a proportion of pyroxyline.

THIOCARBAMIDE (Fr., *Sulfo-urée*, *sulfocarbamide*; Ger., *Thiocarbamid*, *Sulfoharnstoff*)

Synonyms, sulphourea, thiourea. $\text{CS}(\text{NH}_2)_2$. Molecular weight, 76. Solubilities, 1 in 11 water, very soluble in alcohol and ether. White

lustrous crystals obtained by heating ammonium sulphocyanide for two hours at a temperature of 322° F. (161° C.), when the ammonium salt is converted without loss or gain into its isomeric molecular compound thiocarbamide. Waterhouse suggested it as an addition to the eikonogen developer to obtain reversal by direct exposure, and it is also used for toning with gold. The most satisfactory formula for this is the following, first suggested by Hélain :—

Gold chloride (1 %
sol.) . . . 120 mins. 25 ccs.

Add—

Thiocarbamide (2 %
sol.) . . . 65–71 mins. 13.5–15 ccs.

fill the precipitate first formed is redissolved, then add—

Citric acid . . . 24 grs. 5.5 g.
Distilled water to . 10 oz. 1,000 ccs.

And finally—

Salt . . . 48 grs. 11 g.

The prints should be rather deeply printed, and immersed in a 10 per cent. solution of salt prior to toning. This bath is economical, and free from any tendency to double tones. This carbamide is used also for clearing yellow stains.

THIOSINAMINE (Fr., *Sulfophénylurée*; Ger., *Thiosinamin*, *Allylsulfoharnstoff*)

Synonyms, allyl sulphocarbamide, allyl sulphourea, allyl thiourea, rhodalline. $\text{CS}(\text{NH}_2)\text{NHC}_3\text{H}_5$. Molecular weight, 116. Solubilities, slightly soluble in water, easily soluble in alcohol and ether. It is in the form of colourless crystals with faint garlic odour, obtained by the action of ammonia and alcohol on allyl sulphocyanate (mustard oil). It has been suggested as a fixing agent, but its solvent powers are very poor compared with "hypo," and its price is high.

THIOUREA (See "Thiocarbamide.")

THOUGHT PHOTOGRAPHY

Many of the "spirit" photographers have claimed to be able to photograph thought. In the *Review of Reviews* for April, 1893, W. T. Stead suggested that additional experiments should be tried to obtain psychic pictures without the agency of the camera, and in the following July an experiment was tried and recorded by Andrew Glendinning. A female medium and clairvoyante held between the palms of her hands an unexposed dry plate enclosed in a dark-slide. The plate was afterwards developed, when the picture of a child appeared upon it. Unfortunately, it is impossible to discover what was the subject of the lady's thoughts. It is recorded that Prof. Jordan, in 1896, placed seven men in front of his camera and asked each one to think of a cat; they did so, and the resulting photograph was "a collective psychical image which is none other than the astral cat in its real essence." Dr. Baraduc, of the Paris Société de Médecine, has stated that by concentrating his mind on a definite object so as to visualise distinctly a picture thereof, the image was impressed on a dry

plate. Several other experiments have been made in the direction indicated, but no properly authenticated result of any importance has been obtained. Many of the so-called thought pictures that have been exhibited require an immense amount of imagination to distinguish any image upon them.

THREE-COLOUR PHOTOGRAPHY

This particular branch of photography is, with the exception of the diffraction and Lippmann's processes, practically the basis of all colour photography. It is based on the theory that by the use of three colours only all the colours of nature can be simulated, either by the use of three lights—red, green, and blue-violet—when optical synthesis is used, or by the aid of three pigments—red, yellow and blue—when the subtractive process is employed on paper or glass.

The first idea of this process was enunciated by Clerk-Maxwell in a lecture before the Royal Institution, in 1861.

Henry Collen, the miniature painter to Queen Victoria, writing to the *British Journal of Photography* (1865, p. 547), threw out a suggestion, which, although theoretically incorrect, shows that he certainly conceived the idea, and apparently in ignorance of Clerk-Maxwell's suggestions.

Ducos du Hauron sent, in 1862, a letter to a M. Lelut, member of the Académie de Médecine et Sciences, in which he describes the principles of three-colour work, and though, like Collen's, they were erroneous, still they are of sufficient interest to warrant inclusion :—

"*Physical Solution of the Problem of Reproducing Colours by Photography.*—The method which I propose is based on the principle that the simple colours are reduced to three—red, yellow, and blue—the combinations of which in different proportions give us the infinite variety of shades which we see in nature. One may now say that analysis of the solar spectrum by means of a glass which only passes one colour has proved that red exists in all parts of the spectrum, and the like for yellow and blue, and that one is forced to admit that the solar spectrum is formed of three superposed spectra having their maxima of intensity at different points. Thus one might consider a picture which represents nature as composed of three pictures superimposed, the one red, the second yellow and the third blue. The result of this would be that if one could obtain separately these three images by photography and then reunite them in one, one would obtain an image of nature with all the tints that it contains."

Here also the theory of colour selection is erroneous, and founded on Brewster's theory, but the above note proves that Du Hauron had really conceived the idea of three-colour work independently of Clerk-Maxwell.

Du Hauron goes on to describe the use of three filters of deep red, deep yellow, and deep blue, and gives a sketch of a chromoscope by means of which the three positives could be seen visually, and even suggests a stereoscopic chromoscope. In November, 1868, Du Hauron took out a French patent for three-colour

work, and here he used red, green and violet filters, thus falling into line with modern practice. In 1865, Baron Rausonnet, of Vienna, attempted to produce three-colour photo-lithographs, but failed to obtain any result, and gave up the idea. In 1867, Charles Cros, a Frenchman, had quite independently been working on the same problem, and in 1869 published his ideas. Cros utilised the principle of monochromatic illumination of his subject, but he did not follow up the subject quite so energetically as Du Hauron, who was the first actually to produce a three-colour print. It was only after the discovery of the principle of orthochromatising that three-colour work made any advances. It is impossible to give a complete historical sketch of the subject, but the above includes reference to the first workers on the subject.

The commonly accepted theory of three-colour work is that the filters and plates must be so adjusted as to give a reproduction in black—that is, in metallic silver—of the three sensation curves according to Clerk-Maxwell, but the requirements of the printing inks, or the projection colours, necessitate modifications; and the generally accepted practice now is that the three filters should have a slight overlap, as follows: The red filter should transmit from $\lambda 7,000$ to $\lambda 5,800$; the green from $\lambda 6,000$ to $\lambda 4,600$; and the blue from $\lambda 5,000$ to $\lambda 4,000$; and equal density should be obtained under each filter.

There is occasionally some little misunderstanding about the printing inks and the projection colours, but this can be cleared up by a very simple explanation. If a black-and-white drawing is photographed, it is obvious that the whites will give the density in the negative, whilst the black, which is the colour in which it is wished to print, gives the shadows, or bare glass, so that obviously we print in the colour that does not act. In projecting a transparency from the negative we should project by white light; therefore we should project by the colour that did act on the negative. Dealing thus with a coloured subject, we use a red screen that cuts out the blue, and therefore print from this negative in the colour that does not act on the negative, namely, blue; using a green screen we cut out the red, and therefore print in red; and with a blue screen, which cuts out the yellow, we print in yellow. For projection, as stated above, we project by the light by which the negatives were taken and, therefore, project the transparency taken through the red screen by red light, that taken by the green screen by green light, and that taken by blue by blue light.

Theoretically, there should be, of course, correspondence between the light cut out by the screens and the light reflected by the inks, but here there is generally a departure from theory, as the theoretically correct inks are not sufficiently permanent to light.

Three-colour work may be divided into photomechanical printing; the superposition of dyed films or pigments, as in the carbon process, in which the principle of subtractive colour mixture is made use of; and the optical

synthesis methods, such as the chromoscope, three-colour projection, and screen-plate processes. The production of filters for this work is treated of under the heading of "Colour Screen or Filter." It is far better to use a panchromatic plate for all three exposures, as the gradations are then more likely to be the same, which may not be the case when plates sensitised for each particular section of the spectrum are employed. In no case should the negatives be harsh, but rather tending towards softness. With correct filters adjusted to the plate with which they are to be used and correct exposure, hand work on the negatives—except for the retouching of pure mechanical defects—should be avoided, as no one can tell from looking at a subject exactly how much of any one of the three printing colours is contained in any colour of the original.

Pinatype is a three-colour process invented by Dr. König, in 1905. Three negatives are first obtained through red, green and blue filters, and from these transparencies are made. Special gelatinised plates, sensitised with potassium bichromate, are exposed under the positives and washed, being then soaked in blue, red and yellow dyes respectively, which are absorbed by the soft or image portions only. The three plates are pressed in turn in contact with moistened gelatinised paper, which takes up the dye; a photograph, or strictly, print, in colours results.

THREE-COLOUR WORK

A term generally applied more particularly to process work and printing in three colours, as distinct from purely photographic methods, which come under the heading of three-colour photography.

THYMOL

An antiseptic obtained from certain volatile vegetable oils, and used as a preservative in mountants.

TIME DEVELOPMENT (See "Development Factorial," "Development, Thermo," and "Development, Time.")

TIME EXPOSURES

Exposures sufficiently long to be given by hand, the duration being determined by closing the lens at will, as distinguished from "instantaneous" exposures, or those that must be given automatically by a mechanical contrivance. A time exposure may be of any duration from a quarter or half of a second up to several hours. If very long, the lens cap will form the most convenient method of uncovering and covering the lens, but for exposures up to eight or ten seconds a mechanical shutter is preferable, as when this is employed the photographer can watch moving foliage or any subject that requires care in seizing the opportunity for making the exposure, and, without touching or looking at the camera, can release the shutter at the critical moment, thus ensuring exposure under the best conditions. If foliage should move or any other accidental necessity arise, he can at once close the shutter, if the exposure is nearly completed, and secure a negative that shows absence of movement. In long time exposures it may frequently become

necessary to give several short exposures to make up the total time. The photographer should acquire the art of capping and uncapping the lens without imparting a tremor to the camera.

For timing exposures, there is nothing better than a chronometer or a watch with a seconds hand. One exposure meter is fitted with a chain which swings to and fro in a given time and is approximately correct. Counting is fairly satisfactory if one has learnt to count always at the same speed, but a second is longer than the average worker imagines, and considerable practice is necessary before one can count without a watch with safety. A common plan is to count in a normal manner, as follows: "One little second," "two little seconds," "three little seconds," and so on, practising this until each sentence takes one second to repeat. For longer exposures, both for camera and dark-room work, a watch or a special dark-room clock is to be preferred.

TIN, BLACKENING (See "Blackening Apparatus.")

TIN CHLORIDE (Fr., *Chlorure d'étain*; Ger., *Stannochlorid*)

Synonym, tin protochloride or dichloride, tin salt, stannous chloride, $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$. Molecular weight, 225. Solubilities, 1 in 1.5 water, soluble in alcohol. It takes the form of white crystals, obtained by the action of hydrochloric acid on tin. It has been suggested for blackening negatives after bleaching with mercuric chloride, but it presents no particular advantage. Hélain's formula is:—

Tartaric acid.	96 grs.	22 g
Tin chloride	96 "	22 "
Distilled water to . . .	10 oz.	1,000 ccs.

TINCAL, OR TINKAL (See "Sodium Borate.")

TINCTURE OF IODINE (See "Iodine.")

TINFOIL (Fr., *Étain en feuille*, *Feuille d'étain*; Ger., *Blattzinn*, *Stanniol*)

An alloy of lead and tin rolled out into thin sheets. The thinnest variety is used for masking negatives, especially in collotype printing, so as to secure clean white margins. Woodbury used tinfoil in his Stannotype process.

A process of using tinfoil instead of paper as a base for photo-lithographic transfers was worked out by Captain Mantell, at the Royal Engineers' Military School, Chatham, its advantage being freedom from expansion when the transfer is damped.

TINT BLOCKS (Fr., *Clichés à teinte*; Ger., *Ton-platten*)

A process block is sometimes printed on a tint ground imitating the effect of an India tint mount; this ground is printed from a "tint block." Sometimes an etched block is used in half-tone work to give a preliminary printing in a lighter tint of ink than the main block. This block is termed a tint block.

TINT PLATES

Copper plates engraved with a mechanical stipple or line ruling for the purpose of pulling

transfers therefrom. Lithographers and process workers use them for applying a tint to some part of an illustration that has to be shaded or darkened in colour. Tint plates have now been almost entirely superseded by shading mediums.

TINTED PRINTS

Printing papers with coloured supports are articles of commerce, as, for example, cream bromide papers and self-toning papers, and pink and mauve P.O.P. Other and much higher and pronounced colours are also supplied. It is a common practice to use white papers and to stain with dyes or tea and coffee.

TINTOMETER

An instrument for measuring and, as it were, analysing the colour in solids and liquids; invented by J. W. Lovibond about 1887. The object is placed at one end of the instrument; from a graded series of standards, made of coloured glasses, numbered according to their depth of colour, the colour of the object is matched. For investigation work, three colour scales are employed (red, yellow and blue), and the glass slips are graded in colour from plain glass to maximum intensity. The instrument itself consists of a double, parallel-sided tube, having at one end an eyepiece and at the other the viewing apertures.

TINTYPE (See "Ferrotypes Process.")

TISSUE (See "Carbon Tissue.")

TISSUE NEGATIVES

In an early type of roll film, the sensitive emulsion was spread upon paper and stripped off after being developed and fixed.

TITHONOTYPE, OR TITHNOTYPE (Fr., *Tithonotypie*; Ger., *Tithonotypie*)

A process for obtaining metallic copies of daguerreotypes by electrolysis, discovered by J. W. Draper, of New York. The daguerreotype was gilded, and left exposed to the air for a few days. The back and edges were next varnished, and copper was electro-deposited upon the daguerreotype image, this taking from twelve to twenty hours. If the work had been done properly, the tithonotype was readily detached without injury to the original, of which it formed a perfect copy. Duplicates could be made from the tithonotype if required.

TITLING NEGATIVES AND PRINTS (See "Lettering Negatives and Prints.")

TOBACCO PRESERVATIVE

One of the many preservatives or organifiers introduced before the days of gelatine dry plates for keeping collodion plates in a good condition for a few days. The formula was: Water, 1 oz.; gum arabic, 10 grs.; tobacco, 20 grs. The mixture was boiled and filtered, then coated upon a sensitive plate.

TOPE

A term that is applied in two distinct ways. It is used in the same sense as in painting, etching,

drawing and kindred arts, to signify the degree of depth of any mass of greys, such a mass being described as a "light" or "dark" tone, a "delicate" tone, etc. A picture is said to be "light" in tone when there are few dark masses, or it is "dark" in tone when the heavy or dark masses preponderate.

"Tone" also indicates the actual colour of a print, brown and red colours being termed "warm" tones, and purple and black colours, "cold" tones.

Light tones are called high, and dark ones low. The more a picture inclines to whites and light greys (or other colour) the higher it is in tone; the heavier and darker it is, the lower it is in tone. (See also "Key.")

"Half-tones" are the shades of colour between black and white, a half-tone image being an image in which the half-tones have been broken up into dots; in contrast with which an ordinary photograph is said to be of "continuous tone."

STONE BLOCKS

Half-tone blocks are often referred to as "tone blocks."

TONING (Fr., *Virage*; Ger., *Tonen*, *Schönen*.)

The operation of changing the colour of a photographic image by changing its composition or depositing another metal. Toning is almost exclusively employed for modifying the silver images on printing-out, bromide, and gaslight papers. It is sometimes adopted in lantern slide making. Details of the processes are given under other headings.

TONING BATHS FOR SILVER PRINTS

A toning bath suitable for almost every brand of gelatine and collodion printing-out paper is:—

Am. sulphocyanide	12 grs.	4.5 g.
Gold chloride	1 gr.	.37 "
Water	5-6 oz.	830-1,000 ccs.

Full working details are given in the article on "Toning P.O.P."

The following toning baths work admirably with some brands of P.O.P.:—

Sodium phosphate	20 grs.	7.5 g.
Gold chloride	1 gr.	.37 "
Water	6 oz.	1,000 ccs.

Sodium formate	15 grs.	5.6 g.
Gold chloride	1 gr.	.37 "
Water	6 oz.	1,000 ccs.

The sodium phosphate and the following baths are all suitable for albumenised paper:—

Sodium acetate	30 grs.	10 g.
Gold chloride	1 gr.	.37 "
Water	7 oz.	1,000 ccs.

This bath should be mixed at least ten hours before required for use.

Sodium bicarbonate	4 grs.	1.2 g.
Gold chloride	1 "	.37 "
Water	7 oz.	1,000 ccs.

Other formulæ are given under the headings "Borax Toning," "Chloride of Lime Toning Bath," "Bennett's Toning Bath for P.O.P.," etc.

TONING BROMIDE PRINTS

There are various methods of toning bromide prints; the most satisfactory being those that produce various shades of brown-black and cold and warm brown, although red tones are very suitable for flower studies and portraits of children, etc. Green and blue tones are the least desirable. In monochrome work it is rarely desirable to imitate the colour of the subject.

In all toning processes, the method of producing the print considerably influences the final colour and quality. A strong, rich print is essential for securing rich tones, and a strong print cannot be obtained from a weak, flat negative. From a good negative, a strong print can only be obtained by correct exposure and full development; over-exposure and short development yield a print that will never tone to a rich colour; the result is always weak and poor. Another source of imperfect results in toning is the very common practice of using one quantity of developer for several prints. Those developed last will invariably give weak and poor colours when toned. Fresh developer should be used for every print, excepting small prints, for which, relatively, a large quantity of solution is employed. For these, two prints may be developed in succession in one quantity of solution, but this should be the limit.

Thorough fixation is essential to success in toning bromide prints; thorough washing is often equally important. Bromide prints should always be dried after fixing and washing before toning; with some processes this affects the colour very materially.

Copper Toning.—Very delicate red tones, red-chalk, or rather sanguine, can be obtained by toning with copper. For the formulæ, see "Copper Toning."

Platinum Toning.—Good sepia tones may be obtained by this method, which is fully described under a separate heading.

Vanadium Toning.—A good green tone can be obtained by this process. (See "Vanadium Toning.")

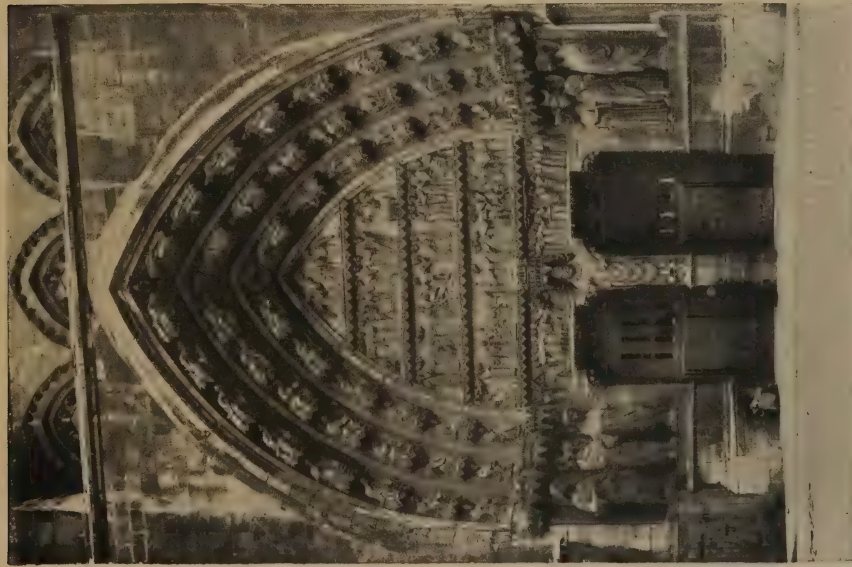
Iron Toning.—Rich blue tones are obtained by iron toning; the bath should be prepared by adding each ingredient in the same order as in the formula:—

Ferric am.-citrate	3 grs.	.62 g.
Pot. ferricyanide	3 "	.62 "
Nitric acid	6 mins	1.2 ccs.
Water	8 oz.	800 "

The print tones rapidly in this solution to a rich blue; it requires washing in various changes of water until the whites lose the stain acquired during toning, and become quite pure. It is better to prolong the washing a little beyond the visible clearing. The permanency of prints toned either by iron or vanadium is doubtful.

"Hypo"-alum Toning.—A method of sulphide toning by means of a solution of "hypo" and alum. The colour is a purple-brown, and the results are thoroughly permanent. Working details are given under the heading of "Alum-'hypo' Toning."

Sulphide Toning.—A process of toning by the use of a solution of sodium sulphide which is in every respect the most satisfactory method of toning bromide prints. Very rich, pure



NORTH DOORWAY, RHEIMS CATHEDRAL



Magnification, 4:82



Magnification, 17

BY ERNEST MARRIAGE, F.R.P.S.

TELEPHOTOGRAPHY

The second and third photographs show the magnifications of the sculptured figures to the right of the doorway obtained by means of a telephoto lens, the camera remaining stationary.

brown colours are obtained, the process is simple and certain, and the prints after toning are quite permanent. The process, one of combined toning and intensification, is fully described under the heading "Sulphide Toning."

TONING, DOUBLE (See "Double Toning.")

TONING AFTER FIXING

A method that has been recommended on account of the occasional loss of tone in the fixing bath after toning. Success depends, as in all toning processes, upon the quality of the print. Prints intended for fixing before toning should be deeply printed, fixed, well washed, and then toned in the ordinary sulphocyanide and gold toner. With some papers, a more satisfactory system is to immerse the fixed and washed prints in a solution of 1 oz. of formaline in 9 oz. of water. The toning bath is then used just warm and kept warm while in use.

TONING AND FIXING COMBINED

A bath very frequently employed for toning and fixing silver prints at one operation. It is not merely the obvious saving of time and trouble that has rendered it a favourite method with many workers, but rather the great advantage that the tone or colour of the prints remains the same after finishing as when taken from the toning bath. In separate toning and fixing, the colour obtained by toning is frequently considerably modified by the subsequent fixing. A serious objection to the combined bath is that prints may be toned to the desired colour before they are properly fixed, and subsequent fading is the inevitable result. Or the bath may contain sulphur, and the tones may be due to this substance rather than to gold, and this also produces prints which will deteriorate quickly. These objections may be entirely obviated by adopting a suitable formula, preferably one that contains neither acid nor alum; keeping stock solutions from which the bath may be prepared when required; mixing sufficient solution for the prints that are to be toned, and throwing away the mixed solution after using it once. Using a combined bath many times in succession is one of the most frequent causes of want of permanence. A reliable formula and method of working will be found under the heading "Bennett's Toning Bath for P.O.P."

TONING LANTERN SLIDES

Lantern slides may be toned by any of the methods given for bromide prints. Some of the toning methods intensify as well as change the colour of the slide—the sulphide, for example—and somewhat destroy the transparency of the image. Copper toning produces attractive red tones, with transparency and delicate quality. (See "Toning Bromide Prints.") The most satisfactory warm and cool brown tones are those produced by development.

TONING PLATINOTYPE PRINTS (See "Platinotype Process.")

TONING P.O.P.

Of the two methods of toning and fixing prints on printing-out silver papers, one is to tone first

and afterwards fix, and the other is to tone and fix at one operation, the second method saving much time and trouble, while capable of producing quite as good results. It is described under the heading "Toning and Fixing Combined."

For separate toning and fixing, the prints require first to be washed for about twenty to thirty minutes in several changes of water; the first two changes should be made as quickly as possible, care being exercised to prevent the prints from clinging together. To prepare the toning bath, two solutions are necessary:—

A. Am. sulphocyanide	. 520 grs.	120 g.
Water to	. 10 oz.	1,000 ccs.
B. Gold chloride	. 15 grs.	3.5 g.
Water to	. 3½ oz.	375 ccs.

To prepare the toning bath, take 2 drms. of A, add 5 oz. of water, and then add slowly 2 drms. of B; in ten minutes the bath will be ready for use. It will be sufficient for four whole-plate prints or sixteen quarter-plates. A proportionate quantity should be prepared for any other number of prints, allowing always ½ drm. each of A and B, and 1½ oz. of water for each whole-plate print. The prints to be toned are placed in the solution and continuously turned over by lifting the lowest print and placing it on top until the desired colour is reached. They are then rinsed in two or three changes of water and fixed for fifteen minutes in the following:

Sodium hyposulphite	. 1½ oz.	165 g.
Liquor ammoniæ	. 5 mins.	1 cc.
Water	. 10 oz.	1,000 ccs.

Take care to ensure free access of the solution to the surfaces of the prints, and to prevent them from clinging together. After fixing, wash the prints, in water frequently changed, for from one to two hours.

An additional method of toning P.O.P. is by means of platinum. The most satisfactory manner of working is by first toning with gold, preferably by the sulphocyanide bath, then, after a short washing, toning with platinum, washing again, and fixing.

An alternative plan is to use a self-toning paper, by which the operation of gold toning is avoided, and then the prints are washed, toned simply with platinum, washed and fixed. Or the prints may be toned first with platinum and then finished in a combined gold toning and fixing bath.

Formulae for platinum toning baths are given under the heading "Platinum Toning"; another is:—

Potassium chloroplatinite	1 gr.	.25 g.
Sodium chloride	. 10 grs.	2.5 "
Citric acid	. 10 "	2.5 "
Water	. 5-6 oz.	500-600 ccs.

Whatever method of toning is adopted, only sufficient of the working solution should be prepared for the prints to be toned; it should be used once, and then thrown away.

TONING, SULPHIDE (See "Sulphide Toning.")

TONING, SYSTEMATIC

A process of toning by which the exact amount of gold, etc., is used, the solution being thrown

away after use. W. J. Wilson was (in 1894) one of the first to publish working details. The amount of gold chloride required to tone safely and thoroughly may be taken as from $1\frac{1}{2}$ to $1\frac{3}{4}$ grs. for each sheet of paper $24\frac{1}{2}$ in. by 17 in., dark or heavy prints requiring more gold than lightly printed ones. Taking $1\frac{3}{4}$ grs. as a fair average (equivalent to .6 gr. per 1 sq. ft.), the following bath may be made up :—

Ammonium sulpho-			
cyanide . . .	. 12 grs.	2'3 g.	
Gold chloride . . .	. 1 "	" 2 "	
Water . . .	. 12 oz.	1,000 ccs.	

Twenty-four minims of this bath will tone 1 sq. in. of P.O.P. print, or the bath may be used in the following proportions :—

	Inches	Sq. Ins.	Oz. Drs.
One whole sheet	$24\frac{1}{2} \times 17$	$= 416.5$	requires 21 0
One piece . . .	15×12	$= 180$	" 9 0
" . . .	12×10	$= 120$	" 6 0
" . . .	10×8	$= 80$	" 4 0
" . . .	$8\frac{1}{2} \times 6\frac{1}{2}$	$= 55.25$	" 2 6½
" . . .	$6\frac{1}{2} \times 4\frac{1}{2}$	$= 30.87$	" 1 4
" . . .	$6 \times 4\frac{1}{2}$	$= 26$	" 1 2½
" . . .	$4\frac{1}{2} \times 3\frac{1}{2}$	$= 15.81$	" 0 6

The above bath is weaker than that originally advocated by W. J. Wilson.

TONING WITHOUT GOLD OR PLATINUM

One of the most popular of the "no gold" baths is the following, which gives rich tones from warm brown to purple. The results are fairly permanent, and the process is widely used for prints required as rough proofs or those which it is not desired to keep for any length of time :—

Sodium hyposulphite . . .	. 2 oz.	220 g.
Lead acetate . . .	. ½ "	28 "
Water (hot) . . .	. 10 "	1,000 ccs.

The bath is ready for use when cold. A dense precipitate is formed and the solution needs to be decanted. The prints are printed more deeply than usual, and are not washed previous to immersion, but well washed afterwards.

TOUCH PAPER

Slow-burning paper strips used for firing a flash-light mixture, which is piled up on one end of the strip and the other ignited. The time taken for burning depends upon the length of the strip, 2 in. or 3 in. being usually enough. The paper is made by soaking blotting-paper in a solution of saltpetre in water, drying, and cutting into strips about $\frac{1}{2}$ in. wide. Another recipe is as follows: Finely powder separately equal parts by weight of antimony sulphide and potassium chlorate, mix together, and add enough shellac, dissolved in alcohol (ordinary French polish answers well) to make a thick cream. Spread this evenly upon paper, allow to dry naturally, and cut up for use.

TRACING PAPER (Fr., *Papier à calquer*; Ger., *Papier zum Durchzeichnen*)

This paper has been recommended for use on the glass side of a negative for the purpose of working upon or for retarding printing. Some of the French tracing "papers" are actually

papier glacé, which consists of isinglass. Ordinary thin paper may be made translucent by coating with thin dammar varnish and allowing to dry; another substance is bleached beeswax dissolved in alcohol and ether. A translucent paper suitable for use with colours mixed with spirit is made by coating paper with bleached shellac 3 parts, mastic 1 part, strong alcohol 20 parts.

In lithography, several varieties of transfer tracing paper are used for making drawings in lithographic writing or drawing ink. These tracing papers have a gelatine surface to render it possible to transfer the ink when the paper is damped and pressed down to stone or metal.

TRACINGS, PRINTING FROM

Tracings made by engineers, architects, etc., are easily duplicated by photographic printing, the iron printing processes being widely used because of their simplicity and cheapness. See under the following headings: "Blue-print Process" (white lines on a blue ground), "Pellet Process" (blue lines on a white ground), "Ferro-gallic Process" (black lines on a white ground), "Kallitype" (brown lines on a white ground), "Ordoverax" (black ink lines on a white ground), etc.

TRAGACANTH (See "Gums and Resins.")

TRANSFER PAPERS

Single transfer paper and final support for double transfer are used in the carbon process (*which see*).

In *process work* and lithography, numerous kinds of transfer papers are used, some for making original drawings upon and others for retransferring impressions from existing stones to plates bearing designs on them. Tracing transfer and writing transfer papers are for making original designs upon with pen or brush and lithographic ink. Scotch transfer, India transfer, and re-transfer papers are for retransferring designs. Grained transfer papers are for making drawings upon with lithographic crayons. Photo-litho transfer paper is for sensitising with potassium bichromate to print under a negative. Decalcomanie transfer paper is for transferring designs to porcelain for vitrifying.

TRANSFEROTYPE

A special kind of bromide paper, widely used many years ago. It was prepared on one side with soluble gelatine and with a specially hardened sensitive emulsion. The wet bromide print was squeegeed, face down, on the support where it was intended to remain. Hot water was poured on the back of the print, which melted the soluble gelatine and released the paper, leaving the image on the support.

The term is now used rather loosely to describe transferred pictures by other processes.

TRANSFERRED LIGHT ACTION ON DRY PLATES

It has often been stated that when an exposed and undeveloped plate is packed in contact with an unexposed plate, film to film, the light action will be transferred. Experiments made with English dry plates have proved that even after ten years' contact no appreciable light action has been transferred. There is a

difference of opinion on the subject, but the photographer can easily test the matter for himself.

TRANSFERRING FILMS FROM NEGATIVES (See "Cracked Negatives.")

TRANSIT BOXES

Boxes specially designed for sending negatives, lantern slides, etc., by post or rail. For negatives, wooden boxes lined with felt or rubber are best. Various kinds of transit boxes are described under the headings "Box, Lantern-slide," and "Packing Negatives for Post."

TRANSLUCENT PAPER (See "Paper Negatives" and "Tracing Paper.")

TRANSMISSION OF PHOTOGRAPHS ELECTRICALLY (See "Photo-telegraphy.")

TRANSMITTER, STEREOSCOPIC (See "Stereoscopic Photography.")

TRANSPARENCIES, CARBON

Transparent positives made by the carbon process. A special tissue for the purpose contains more colour than the tissues for paper prints, and requires from three to five times the exposure necessary for an ordinary print. The exposed tissue is squeegeed to, and developed on, a sheet of glass previously coated with a thin solution of bichromated gelatine, and the remaining work resembles that described for single transfer prints under the heading "Carbon Process."

Glass plates (old negatives cleaned) may be prepared by coating thinly with a solution of—

Gelatine	60 grs.	14 g.
Potassium bichromate	3 "	" 7 "
Water	10 oz.	1,000 ccs.

and, after drying, exposing to daylight to harden the coating. The gelatine must be soaked in cold water for an hour, and then dissolved by heat, the bichromate, dissolved separately in a little water, being added to the gelatine. Prepared glasses may be purchased when obtaining the transparency tissue.

TRANSPARENCY (Fr., *Transparence*; Ger., *Transparent, Durchsichtigkeit*)

A term commonly applied to lantern slides or other positives on glass. (See also "Window Transparencies.")

TREBLE PHOTOGRAPHS

Trick photographs in which a person is shown in three different positions in the same negative. They are produced in much the same way as doubles (*which see*), the best method being to use a black background and give three separate and equal exposures, taking care that the three images do not overlap.

TRIAMIDOPHENOL (Fr. and Ger., *Triamidophenol*)

$C_6H_2OH(NH_2)_3 \cdot 3HCl$. Molecular weight, 248.5. It is in the form of white needles, and has been recommended as a developer, but it is not much used.

TRICHROM EMULSION

A collodion emulsion sensitised with dyes for the purpose of making the selective negatives for three-colour printing. The emulsion is either panchromatised or issued with three different sensitisers, which can be added to the emulsion just before use, and which sensitise it respectively for red, green, and violet.

TRICHROMATIC PHOTOGRAPHY (See "Three-colour Photography.")

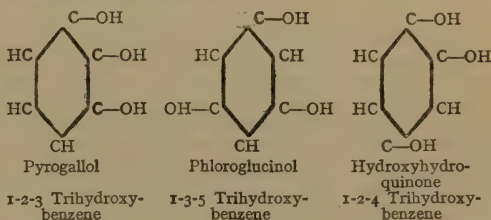
TRICK PHOTOGRAPHY

Photography lends itself to the production of a variety of "trick" effects, which may be classified as: (1) Those produced by dividing the exposure and making alterations in the subject during those times when the lens is covered (*see, for example, "Doubles," "Treble Photographs," "Psychic Photography," "Theatrical and Kinematograph Photography," etc.*); (2) those produced by manipulations in printing, as by the methods described under the heading, "Combination Printing"; (3) those produced by chemical manipulations (*see, for example, "Magic Photographs"*).

TRICOLOUR PHOTOGRAPHY (See "Three-colour Photography.")

TRIHYDROXYBENZENE

Synonym, trihydric phenols. Three isomeric compounds, all possessing the same formula, $C_6H_3(OH)_3$, but differing in constitution. They are interesting because pyrogallol or pyro is one of them, and their graphic formulæ may be represented as follows:—



It will be noted that the hydroxyl groups (OH_2) are in different positions in the benzene ring, their positions being shown by the numbers 1-2-3, etc., in the second line of the titles. In each case one hydroxyl group has replaced one hydrogen atom.

TRIMETHYLAMINE (Fr., *Triméthylamine*; Ger., *Trimethylamin*)

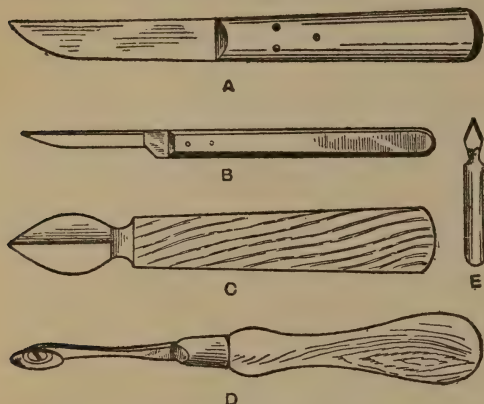
$(CH_3)_3N$. Molecular weight, 59. A colourless gas obtained by the action of ammonia on methyl iodide. A 10 per cent. aqueous solution has been suggested as the accelerator for development, but its most unpleasant smell renders it of small practical use. It was employed in the Russian developer (*which see*).

TRIMMER (See "Print Trimmer.")

TRIMMING KNIFE (Fr., *Canif à découper*; Ger., *Beschneidmesser*)

The knife used in trimming photographic prints and enlargements previous to mounting.

Many workers prefer a good penknife to the many patterns of knives made especially for the purpose. The average type of trimming knife is represented by A and B; C resembles a surgeon's scalpel, and is useful for many other purposes, such as mount-cutting, retouching, etc. D is a wheel trimmer, which, with due



Five Types of Trimming Knives

care, may be employed for trimming wet prints as well as dry; while E is a trimming nib, useful for cutting circular and oval prints, and intended for insertion into an ordinary penholder. Trimming knives should be sharpened at intervals by rubbing on a fine oil-stone. The trimming machine, or "print trimmer" (which see), is likely to supersede the knife.

TRIMMING PRINTS

Prints are trimmed, or cut down, partly to get rid of bare or rough edges, and partly to cut away those outside parts of the picture that are not required. A good method of deciding just how much of a print should be retained is to cut two L-shaped pieces of cardboard and adjust those on the print so that they form a rectangle including just the portion required. This is marked with pencil and the print trimmed accordingly.

The actual cutting may be accomplished with no more elaborate apparatus than a sharp knife, a steel straight-edge, and a sheet of glass or zinc to cut upon. In addition, a T-square or set-square must be used to secure accurate right angles. Although prints are generally trimmed dry, it is sometimes required to cut them while wet, and for this purpose a wheel trimmer must be used.

Trimming is greatly facilitated by employing one of the many machines made for the purpose. These usually take the form of a rectangular board with a guillotine blade working along one edge (see "Print Trimmer"). They are generally fitted with a scaled rule to assist in cutting to given dimensions. Rectangularity is of course secured automatically. Other apparatus is made for cutting circular prints of different diameters. Cutting shapes are also made, particularly for ovals.

Quite apart from the mechanical trimming of prints, much judgment and taste is demanded

in deciding just how much of a print shall be cut away to secure the best result. There should be no hesitation in sacrificing all that hinders, rather than helps, the proportion, composition, and concentration of the subject. However carefully arranged on the plate, few prints do not gain by judicious subsequent pruning.

TRI-NITRO-PHENOL

Synonyms, carbazotic acid, picric acid. $C_6H_2(NO_2)_3OH$. Molecular weight, 229. It is obtained by dropping carbolic acid into nitric acid, and its salts are explosive. It is in the form of yellow crystals, which are very bitter to the taste. It is used principally as a dye.

TRIOXYMETHYLENE (See "Paraformaldehyde.")

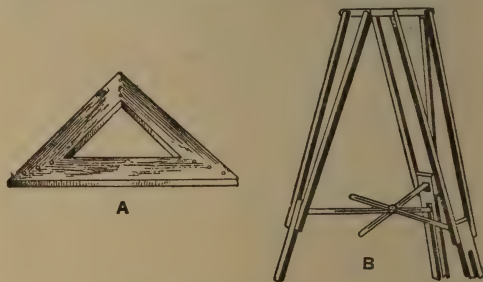
TRIPLER LENS

A lens consisting of three separate combinations.

TRIPOD (See "Camera Stand.")

TRIPOD HOLDER OR SUPPORT

An arrangement to prevent the legs of the tripod slipping on polished floors, stone pavements, etc. Perhaps the simplest way of securing this end is to have a wooden triangle, as shown at A, with holes bored at the angles at which the points of the tripod legs may be inserted. This is often useful in architectural photography, or when it is desired to use a field



Tripod Holders or Supports

camera in an ordinary room for portraiture or copying. A more portable application of this idea consists of three wooden arms hinged together to fold up when not in use, and having holes at the ends. Slotted brass plates are also made which are hinged at one end to the legs of the tripod, as shown at B, a clamping screw being passed through the three slots and tightened up when the tripod is suitably adjusted.

TRIPOLI (Fr., *Tripoli*; Ger., *Tripolith*)

A siliceous pulverulent earth used for cleaning glass, generally mixed with alcohol and ammonia.

TRITURATION (Fr., *Trituration*; Ger., *Zerpulverung*)

The rubbing up of a powder or other substance in a mortar.

TROPICS, PHOTOGRAPHY IN THE

Light, flimsy cameras cannot withstand the effect of tropical heat for long, the shutters of

the dark-slides refusing to open and close and the woodwork generally going wrong. The camera should be well made of thoroughly seasoned mahogany, brass-bound for preference; waterproof glue should be used, or the bellows should be attached by means of brass strips. Cloth bellows are more immune from insect attacks than those of leather. Rustless metal fittings are better than those of wood. Plates should be packed in oiled paper, tinfoil, or in soldered tin-plate cases. Developers may be carried in concentrated form. The risk of melting the wet film during development must be guarded against, hardening with formaline being advisable. Plates should be dried out of the reach of insects. As regards the developer, the use of a more stable alkali than sodium carbonate is recommended by experienced travellers, and the diamidophenol and metol-hydroquinone developers are often advocated.

TROUGH, ETCHING

A shallow tray of earthenware or pitch-lined wood for the purpose of etching zinc and copper plates. The ends are usually covered over for a few inches to prevent the solution splashing over when the tray is rocked. The troughs are sometimes mounted on a machine for mechanically rocking them.

TUBE, CROOKES' (See "Crookes' Tube.")

TUBE, FOCUS (See "Crookes' Tube.")

TULOL

A developing compound introduced by Dr. Liesegang, of Düsseldorf, in 1899. It was a green pulpy mass put up in collapsible tubes. When required for use 1 part was dissolved in 50 parts of water.

TURMERIC (Fr., *Curcuma*; Ger., *Kurkuma*, *Gelbwurzel*)

Synonyms, curcuma, Indian saffron. It is the rhizome of *Curcuma longa*, obtained from tropical climates. It has been used for making yellow screens and in orthochromatic collodion, but has fallen into disuse. An alcoholic tincture of turmeric is used to stain bibulous paper for a test paper, which turns a reddish brown colour with alkaline earths, a brown colour with boric acid, and a bright sulphur yellow with other acids.

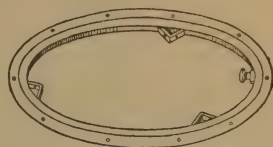
TURNBULL'S BLUE (Fr., *Bleu de Turnbull*; Ger., *Turnbullschzes Blau*)

A bright blue ferrocyanide of iron, $\text{Fe}_5(\text{CN})_{12}$, formed by the action of potassium ferricyanide on a ferrous salt and forming the image in the iron printing process when the print is developed with ferricyanide.

TURNTABLE (Fr., *Table tournante*; Ger., *Drehscheibe*)

An arrangement permitting a field camera to be turned round in any direction on the tripod, to which it is directly attached. As illustrated, it consists of a brass ring let into the

camera baseboard, in which revolves a second ring having projecting eyes to fit the pegs on the tripod legs. A milled-head screw is provided to clamp the turntable in any position. The advantages of the turntable, in addition to the ease with which the camera may be pointed as desired, are that there is no loose tripod head to carry or screw to get mislaid, while the hole in the baseboard allows it to fold over the lens and shutter, so that a more portable construc-



Turntable

tion of the camera becomes possible. Greater rigidity is said to be obtainable with a turntable than with the ordinary tripod head, though some workers dispute this.

In process work, a turntable is generally a feature on the camera stand used for copying, its object being to turn the camera sideways when the prism is used, and to turn it parallel to the length of the stand for direct work.

TURNTABLE TRIPOD TOP

A tripod head furnished with a revolving platform. It differs from the turntable proper in being attached to the stand itself instead of to the camera.

TURPENTINE (Fr., *Térébenthine*; Ger., *Terpentin*)

A colourless volatile liquid obtained by distillation from an oily resinous substance extracted from various pine and fir trees. "Spirit" and "oil" of turpentine, and "turps," are identical. Rectified turpentine is a purer variety. Venice turpentine is an exudation from the larch, and occurs in the form of a honey-like product, very sticky and tenacious, and smelling of turpentine. Canada balsam is a similar product.

In process work, turpentine has numerous uses. Rectified turpentine is used for developing bitumen prints, and for thinning the transfer ink used for inking up albumen prints. Commercial turpentine is largely used for cleaning the ink off slabs, rollers, blocks, etc.

TWADDEL HYDROMETER (See "Hydrometer.")

TWIN-LENS CAMERA

A hand-camera with a full-size finder, having a lens of the same focal length as is used for taking the photograph. The image is reflected by a fixed mirror inclined at an angle of 45° to a horizontal screen, and may be focused right up to the moment of exposure. Though bulkier than the reflex, the twin-lens camera has the advantage that the image is always in view.

U

ULLMANINE

A white water-colour pigment much favoured by retouchers of photographs for reproduction. It works well with the aerograph, photographs white, and does not change colour.

ULTRA-VIOLET RAYS (Fr., *Rayons ultra-violets*; Ger., *Ultraviolette Strahlen*)

A region of the spectrum lying beyond the visible violet, the commencement of which is sometimes known as the lavender rays. The research in this region of the spectrum has been much facilitated by the fact that the haloids of silver are extremely sensitive to it, and one has but to use a spectrograph fitted with quartz lenses and Iceland spar prisms to obtain a spectrogram of the same. Most of the work on the ultra-violet, however, is done with concave reflection gratings, which, forming a real image without the aid of lenses, introduce no absorptive medium. The farthest yet reached by photographic means is λ 1,181 by Victor Schumann using a quartz spectrograph with silver iodide deposited on glass with but very little gelatine as binding agent and with the plate and spectrograph exhausted of air, as he found that both gelatine and air were rather strong absorbents of the extreme ultra-violet. Ordinary glass does not transmit beyond about λ 3,400.

In the ultra-violet lies the region of the greatest photochemical action, and as has been pointed out in the description of the diffraction grating, there is always an overlapping of the ultra-violet of the one order on the red of the preceding one, and therefore in spectrographic work this must be looked for and absorbed by the use of yellow filters. In ordinary photography, if anything like correct colour rendering is required also, the ultra-violet must be absorbed, for it is obvious that, as we do not see this region, any action on the plate would give a false rendering of the colour. Eder has given the following interesting

table which shows the relative action of the ultra-violet rays in

	Effect of visible spectrum	Effect of ultra-violet
I.—Silver bromide with development—		
(a) The photographic effect of daylight (reflected from white paper) is composed of...	62 %	38 %
(b) Photographic effect of magnesium light (from white paper) ...	30 %	70 %
(c) Argand gas burner (from white paper) ...	80 %	20 %
II.—Silver chloride with development—		
The photographic effect of daylight (reflected from white paper) is composed of ...	1-2 %	98-99 %

When using artificial lights such as the electric arc, the mercury vapour lamp, and magnesium ribbon, it may be considered that the bulk of the photochemical action lies in the ultra-violet. The practical absorbents of the ultra-violet are æsculine and filter yellow K.

UNAL

Rodinal in powder form requiring to be mixed with water to make a developer ready for use.

UNDULATORY THEORY (See "Wave-lengths.")

UNIFORM STANDARD (U.S.) STOPS (See "Diaphragms.")

UNIT OF LIGHT (Fr., *Étalon photométrique*; Ger., *Lichteinheit*)

Different units have been adopted by various countries. The British standard is a spermaceti candle burning about 120 grs. per hour; the height of the flame from where the wick begins to char to the top of the flame should be 45 mm., and the top of the wick should turn over towards the edge of the flame. The candle should be lit at

COMPARISON OF LIGHT STANDARDS (SCHAUM).

	Hefner Lamp H.K.	Bougie decimale and British standard candles	German standard candle = D.V.K.	Carcel Lamp	10 c.-p. Pentane Lamp	Violle's unit
Hefner lamp.	1	0.877	0.833	0.0936	0.0909	0.0439
Bougie decimale and British standard candle	1.14	1	0.950	0.106	0.104	0.05
German candle	1.20	1.05	1	0.111	0.109	0.053
Carcel lamp	10.8	9.47	9.0	1	0.982	0.474
10 c.-p. pentane lamp	11.0	9.65	9.17	1.02	1	0.483
Violle's unit.	22.8	20.0	19.0	2.11	2.07	1

least five minutes before use; there should be a well formed cup of melted wax, and the flame should be well shielded from draughts.

The French standard is the Carcel lamp, burning 42 g. of colza oil per hour in a circular hollow wick lamp.

The German standard is the Hefner-Kerze, that is, the light emitted by the Hefner-Altenack amyl-acetate lamp.

The German standard candle has a flame height of 50 mm.

The Vernon-Harcourt 10 c.-p. pentane lamp and the Harcourt-Simnance 1 c.-p. pentane lamp are also used, especially the former. These lamps burn a mixture of air and pentane vapour.

Violle's unit is the light emitted by the sq. cm. of glowing platinum, and is extremely difficult to reproduce.

The bougie decimale of the Geneva Congress (1896) is the Hefner lamp reduced to the one-twentieth of Violle's unit.

Other standards of less general use have been suggested by Werner-Siemens and Lummer-Kurlbaum. The table at the foot of page 550 shows the relation between the above units.

UNIVERSAL DEVELOPER

Any developer which will serve alike for dry plates, bromide and gaslight papers and lantern plates. The metol-hydroquinone developer is a popular universal developer, but the name "universal" was probably first used by the Ilford Company for a developer in 1891:—

A. Hydroquinone	. 80 grs.	18 g.
Potass. bromide	. 15 "	3.5 "
Sodium sulphite	. 1 oz.	110 "
Water to	. 10 "	1,000 ccs.
B. Sodium hydrate	. 50 grs.	11.5 g.
Water	. 10 oz.	1,000 ccs.

For negatives use equal parts of A and B; for bromide papers, one part A, one part B, and one part water; for lantern plates equal parts of A and B.

UNIVERSAL LENS

A symmetrical anastigmat lens, highly corrected, and suitable for almost any kind of work.

UNOFOCAL LENS

A lens, invented by Rudolph Steinheil, of Munich, working at a large aperture. Astigmatism and other kinds of aberration are eliminated by employing unusually thin and



Unofocal Lens

transparent glasses of very slight curvature. The four elements (*see* illustration) are of the same refractive index and focal length, there being slight distances between them so as to prevent one combination neutralising the other. The lens has great rapidity, gives good definition, and has excellent covering power.

URANIC SALTS (Fr., *Sels uraniques*; Ger., *Uranylsalzen*)

Uranium forms two classes of salts, the uranous and uranic. The latter are readily reduced to the uranous state by the action of light in the presence of organic matter, and this forms the basis of several printing processes.

URANIN (See "Eosine.")

URANIUM ACETATE (Fr., *Acétate d'urane*; Ger., *Uranylacetat*)

Synonym, uranyl acetate. $\text{UO}_2(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$. Molecular weight, 426. Solubilities, very easily soluble in water and alcohol. It is poisonous, the antidote being cobalt nitrate and emetics. It is in the form of small yellow crystals or crystalline powder, obtained by dissolving uranic oxide in acetic acid. It generally contains a little basic salt; therefore a perfectly clear solution cannot be obtained without the addition of acetic acid. It has been suggested in place of the uranyl nitrate.

URANIUM CHLORIDE (Fr., *Chlorure d'urane*; Ger., *Uranylchlorid*)

Synonyms, uranyl chloride or oxychloride. $\text{UO}_2\text{Cl}_2 \cdot \text{H}_2\text{O}$. Molecular weight, 361. Solubilities, soluble in water and alcohol. It is poisonous (*see* "Uranium Acetate"). It occurs as flat deliquescent greenish yellow plates, obtained by dissolving uranic oxide in hydrochloric acid. It can be used as a sensitive salt for printing out, and also confers hardness or increase of contrast when added to a chloride emulsion.

URANIUM COLLODION PROCESS (See "Wothly's Process.")

URANIUM FLUORIDE SCREENS

Fluorescent screens (*which see*) coated with uranium fluoride.

URANIUM INTENSIFIER

An intensifier which gives great additional printing power to thin negatives, the effect not being permanent. A simple formula is:—

Uranium nitrate	. 40 grs.	9 g.
Potass. ferricyanide	. 40 "	9 "
Acetic acid	. 27 mins.	6 ccs.
Water	. 10 oz.	1,000 "

A well-washed negative assumes in this a reddish-brown colour. It is next briefly washed in water slightly acidified with acetic acid, and finally in plain water until the stain has gone. Any "hypo" left in the film will produce red stains, while any iron in the water, say rust from the waterpipes, will produce blue ones. The intensification may easily be removed by placing the negative in a weak solution of sodium carbonate or in ammonia, or by prolonged washing. The negative may be treated locally by intensifying the whole in the usual way and working over any parts that are too dense with a camel-hair brush dipped into a weak solution of ammonia and soda. Many other formulæ have been recommended, Dr. Lüppo Cramer's (used as above) being noteworthy. The originator claims that his formula, given on the next page, keeps well in the dark and gives a clear image.

Potass. ferricyanide (10 % sol.)	2 parts
Uranium nitrate (10 % sol.)	5 "
Potassium oxalate (10 % sol.)	5 "
Hydrochloric acid (10 % sol.)	1 "
Water	10 "

Washing is complete when the stain has disappeared from the shadow (clear) portions of the negative. When this stain is obstinate and there is a danger of the whole of the intensification being removed by prolonged washing, it is best to apply a 2 per cent. solution of ammonium sulphocyanide. This bath should not be used when the negative is to be worked upon locally with ammonia. Negatives intensified with uranium keep better if varnished, failing which store them in a dry place, not exposed to a strong light.

URANIUM NITRATE (Fr., *Azotate d'urane*; Ger., *Uranylsalpetersäure*)

Synonyms, uranyl nitrate, uranium oxynitrate. $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$. Molecular weight, 504. Solubilities, very soluble in water, alcohol and ether. It is poisonous (see "Uranium Acetate"). It is in the form of yellow efflorescent crystals with a greenish lustre by reflected light, obtained by dissolving uranic oxide in nitric acid. It is used for printing out, and in conjunction with potassium ferricyanide to tone bromide prints and intensify negatives, brown or reddish-brown uranyl ferrocyanide being formed on the image, which is partially soluble in water.

URANIUM PRINTING

The first uranium printing processes were worked out by J. C. Burnett (1857-8) and Niepce de Saint Victor, who took out an English patent in 1858. Paper was floated upon a 1 in 30 solution of uranium nitrate, dried in the dark, exposed under a negative to daylight until a faint image printed out, developed by floating on a bath of silver nitrate (40 grs. to the ounce) or upon a solution of gold chloride (9 grs. to the ounce), then washed and dried. In 1864 a process in which the uranium and silver were mixed with collodion and applied to paper was patented by Wothly. (See "Wothly's Process.")

One uranium process has points of similarity with platinotype. Paper is coated with ferrous oxalate in the proportion of 1 gr. to each square inch of paper, each ounce of the solution containing also 1 gr. of mercuric chloride. When dry the paper is exposed in contact with a negative and developed on the following bath:—

Gold chloride	3 grs.	7 g.
Uranium nitrate	45 "	10.5 "
Water	3 oz.	300 ccs.

It is washed, fixed in a weak solution of hydrochloric acid, washed again and dried. Other formulae have been published.

Uranium for Gaslight Printing.—In Dr. J. Bartlett's process (1906), the paper is sized with gelatine containing potash alum and oxalic acid, and sensitised with—

Silver nitrate	275 grs.	63 g.
Uranium nitrate	4½ oz.	495 "
Distilled water	8 "	800 ccs.

Float the paper on this bath for three minutes, dry in the dark, and keep free from moisture.

On account of the radiations from uranium it is necessary to prepare and use the sensitive solution in the dark-room. Exposure is made under a negative in the usual way; with an average negative, from twenty to sixty seconds will be enough at 6 in. or 8 in. from a gas mantle; one to five seconds to sunlight, and thirty seconds to dull daylight. The print is then developed in the following:—

Ferrous sulphate	1 oz.	110 g.
Tartaric acid	½ "	55 "
Sulphuric acid	60 mins.	12.5 ccs.
Glycerine	60 "	12.5 "
Water	10 oz.	1,000 "

The image develops rapidly and varies from brown to a warm black. Should the whites not be pure, due to over-exposure, add tartaric acid to the developer; the tendency to discolour the whites is entirely prevented by adding a trace of nickel nitrate to the original coating solution, but this renders the paper less sensitive. A rinse in weak acid or plain water completes the process.

URANIUM TONING

Uranium toning is really a modified form of intensification, and is not therefore suitable for dense prints. It is not considered to yield lasting results. It resembles the process described under the heading "Uranium Intensifier." J. Weir Brown's one-solution formula is:—

Glacial acetic acid	1 drm.	12.5 ccs.
Potass. ferricyanide	3 grs.	7 g.
Uranium nitrate	3 "	7 "
Water	6 oz.	600 ccs.

This acts slowly and less water may be used in order to make it work more quickly. Many modifications have been made in the formula, and the solutions which appear to find the most favour are:—

A. Uranium nitrate	45 grs.	10.5 g.
Distilled water	10 oz.	1,000 ccs.
B. Potass. ferricyanide	45 grs.	10.5 g.
Glacial acetic acid	2 drms.	25 ccs.
Distilled water	10 oz.	1,000 "

Uranium persulphate is said to act in precisely the same way as the nitrate above mentioned. The two solutions keep indefinitely as long as they are not mixed. For use, mix equal parts of A and B, and if this works too rapidly dilute with water. The prints should not have been developed with ferrous oxalate, as iron causes greenish spots to appear. Metol-hydroquinone developed prints tone excellently, especially if the toning is to be carried no farther than the sepia. Amidol developed prints tone to a full red. Prints if dried after washing should be immersed in water previous to toning so that the toner may work evenly. Toning begins as soon as the prints are immersed in the toner; starting with a warm black the tones progress through the various shades of brown to red, and the image increases in density at the same time. A little before the desired tone has been reached the prints are transferred to a bath of weak acetic acid (about 100 drops to 10 oz. of water); after two or three minutes, they are washed by soaking in still water until the yellow stain has

disappeared. If washed in running water colour will be washed away, leaving a patchy result.

Dilute citric acid (10 grs. to the ounce), and oxalic acid (5 grs. to the ounce), are said to give clearer tones than when acetic acid is used.

Permanent yellow stains are caused by insufficiency of acid in the toner, the acid keeping the gelatine soft and facilitating the washing out of the stains. The last mentioned may be removed by dabbing them with cotton-wool soaked in a very weak solution of ammonium sulphocyanide. The toned image can be restored to its original state by soaking in a weak solution of ammonia or sodium carbonate and washing well.

Uranium may also be used for platinum prints:—

Uranium nitrate . . .	5 grs.	1 g.
Potass. ferricyanide . .	5 "	1 "
Glacial acetic acid . .	5 mins.	1 cc.
Ammonium sulphocyanide. . .	25 grs.	5 g.
Water	10 oz.	1,000 ccs.

Toning is carried out in the manner described for bromide prints above.

Uranium is also used in combination with gold for ordinary P.O.P. (gelatino-chloride) prints. The bath is—

Sodium bicarbonate . .	10 grs.	1 g.
Sodium chloride . . .	30 "	3 "
Sodium acetate . . .	60 "	6 "
Water	15 oz.	750 ccs.

Dissolve and add—

Uranium nitrate . . .	5 grs.	25 g.
Gold chloride . . .	4 "	2 "
Water	20 oz.	1,000 ccs.

The toner gives brownish black or pure black tones according to the quality of the negative used for printing from. The bath must not be acid. After toning, the prints are fixed in an alkaline fixing bath and washed as usual.

URANIUM, RECOVERING

Uranium is recovered by adding to the old baths aqua regia, which destroys the ferricyanide, and then adding liquor ammoniæ in excess. Collect the precipitate, wash with hot water, and boil with slight excess of acetic acid; then, on evaporating to dryness, uranium acetate will be left.

URANOTYPE

Prints made by the uranium mercuro-uranotype, and the platino-uranotype processes are known as uranotypes.

URANYL NITRATE (See "Uranium Nitrate.")

UVIOL

A term applied by Schott and Genossen, of Jena, to a variety of glass which is transparent to the ultra-violet rays. The name is derived from the words *ultra-violet*

V

VACUUM TUBES (See "Crookes' Tube" and "X-ray Photography.")

VANADIUM CHLORIDE (Fr., *Chlorure de vanade*; Ger., *Chlorvanadium*)

Synonyms, hypovanadic hydrochloride, divanadyl tetrachloride, $2\text{VO}_2 \cdot 4\text{HCl} \cdot 3\text{H}_2\text{O}$. Molecular weight, 366. Solubilities, very soluble in water and alcohol. It is a dark green syrupy deliquescent liquid obtained by dissolving vanadic anhydride in hydrochloric acid. It is used for toning bromide prints green, and also in the Donisthorpe process.

VANADIUM PRINTING

The brothers Lumière produced a vanadium printing paper in 1894. Paper with a gelatine coating is sensitised with a solution of vanadium chloride in alcohol and water, dried, and printed under a positive transparency. The joint positive image so produced needs to be treated with a solution of paramidophenol, washed, and any yellowness in the high lights removed in a weak bath of hydrochloric acid, afterwards washing free of acid.

M.M. Lumière found potassium vanadium tartrate the best salt to use, and they prepared it by dissolving vanadium pentoxide in potassium bitartrate.

VANADIUM TONING

Vanadium chloride was first used for toning bromide prints by Somerville in 1903. A formula is:—

Ferric chloride . . .	10 grs.	2.3 g.
Oxalic acid (sat. sol.) .	1½ oz.	125 ccs.
Vanadium chloride . .	20 grs.	4.6 g.
Nitric acid	50 mins.	10 ccs.
Water to	5 oz.	500 "

Then add, stirring the while, 10 grs. of potassium ferricyanide dissolved in 5 oz. water. Tone for one to two minutes, the longer the immersion the lighter being the green. Wash for ten minutes, and fix in a solution of 2 oz. of "hypo" and 200 grs. of boric acid in 10 oz. of water; finally wash for ten minutes.

VANDYCK GRAVURE

An American imitation of Rembrandt photo-gravure.

VANDYKE PROCESS

A photo-lithographic process invented by F. Vandyke, of the Survey of India Office, Calcutta, and used largely for map printing in British and Colonial Government printing offices. Thin zinc plates are grained with sand, and coated with a fish-glue enamel printing solution, the

following being a suitable formula:—Fish-glue, 1 oz.; ammonium bichromate (20 per cent. solution), 2 oz.; water, 6 oz.; chromic acid (10 per cent. solution), 5 mins. The copy, drawn or printed in black on white paper or a transparency on glass or celluloid, is placed in contact with the film side of the plate, and exposure made either to daylight or to an arc lamp. The plate is developed in plain water until the glue is removed from the lines, and it is then dyed with aniline dye, producing a negative image on the zinc. The following ink is next rolled over it:—Powdered bitumen, 4 oz.; lithographic chalk printing ink, 1 oz.; lithographic writing ink, 1 oz.; Burgundy pitch, 1 oz. These ingredients are mixed together, with the aid of gentle heat, and sufficient turpentine added to dissolve the mass. After the plate has been inked it may be developed in water containing about 48 mins. of hydrochloric acid per pint of water, rubbing gently with cotton-wool. The result is that the image is reversed, yielding black lines on the plain ground. The plate is then treated in the usual way for lithographic printing.

VANSANT'S INTENSIFIER

A modification of the mercuric chloride intensifier. The bleached negative is washed and immersed in a freshly prepared bath of water 4 oz., gallic or tannic acid 60 grs., caustic potash 2 grs.; it is then washed and dried.

VAPOGRAPHY

A synonym for atmography.

VARNISH, REMOVAL OF

Varnishes may be removed by soaking the negative, etc., in the solvent used for making the varnish; generally, this solvent is alcohol (methylated spirit). In the case of celluloid varnish, acetone, amyl acetate, etc., must be used. The negative is immersed in a bath of the solvent, allowed to remain for several minutes, with occasional rocking, and then while in the bath rubbed well with cotton-wool. Another solvent is a mixture of 10 parts of alcohol, 10 parts of water, and 1 part of caustic potash, after treatment with which wash the negative in water.

VARNISHES (Fr., *Vernises*; Ger., *Firnisse*, *Lacke*)

Spirit varnishes are the most widely used for negatives upon glass, but for film negatives water varnishes are used, because of the action of the spirit upon the celluloid. Cold varnishes are more easily applied than warm ones, but take longer to dry. Some approved formulæ are:—

FOR HOT VARNISHING—

- | | |
|----------------------------------|------------|
| (1) Bleached shellac . . . 1 oz. | 110 g. |
| Alcohol . . . 10 " | 1,000 ccs. |

Keep in a corked bottle in a warm place, and shake up at intervals until dissolved. Set aside to settle, and then decant the clear part for use.

- | | |
|---------------------------------|------------|
| (2) Orange shellac . . . 1½ oz. | 69 g. |
| Turpentine . . . ¼ " | 14 " |
| Mastic . . . ¼ " | 14 " |
| Castor oil . . . 1 dr. | 6.25 ccs. |
| Sandarach . . . 1½ oz. | 69 g. |
| Methylated spirit 20 " | 1,000 ccs. |

Place all except the castor oil in the spirit, and

shake at intervals till dissolved. Filter or allow to stand, pour off the clear portion, and add the castor oil, which gives elasticity to the film.

- | | |
|---------------------------------|------------|
| (3) Orange shellac . . . 1½ oz. | 138 g. |
| Methylated spirit 10 " | 1,000 ccs. |

Mix as above, and when clear add 20 mins. or 4 ccs. of castor oil, or ¼ oz. or 25 ccs. of spike oil or turpentine. The addition of a teaspoonful of chalk or whiting assists to clear the varnish.

FOR COLD VARNISHING—

- | | |
|---------------------------|----------|
| (1) Gold size . . . 1 oz. | 110 g. |
| Benzole . . . 1 " | 100 ccs. |

This was largely used in the early days. It dries rather slowly.

- (2) *Celluloid Varnish* (see "Celluloid").

Monckhoven's Water Varnish

- | | |
|---------------------------------------|----------|
| (3) Shellac . . . 1 oz. | 110 g. |
| Sodium carbonate (saturated sol.) 8 " | 800 ccs. |

Allow to stand for twenty-four hours, pour off the liquid and replace with clean water; boil till the shellac is dissolved, allow to stand, decant, and filter.

Borax Varnish

- | | |
|-----------------------|------------|
| (4) Borax . . . 1 oz. | 55 g. |
| Shellac . . . 5 " | 275 " |
| Water . . . 20 " | 1,000 ccs. |

Dissolve the borax in boiling water, add the shellac slowly, and keep hot till dissolved. When cool, pour off the clear part for use.

FILM VARNISHES—

Either a shellac or a celluloid varnish given above, as is suitable, and the films may be varnished wet or dry. For wet films use—

- | | |
|--------------------------|----------|
| (1) Borax . . . 120 grs. | 28 g. |
| Sodium carbonate 30 " | 7 " |
| Hot water . . . 5½ " | 550 ccs. |

When dissolved, add 1 oz. or 110 g. of broken gum lac, and when this has dissolved add 20 mins. or 4 ccs. of glycerine, and more water to make 10 oz., or 1,000 ccs. in all. Allow to stand, or filter, and use the clear part. The film is immersed bodily for a minute or two and then pinned up to dry. For dry films use—

- | | |
|------------------------|------------|
| (2) Dammar . . . 1 oz. | 110 g. |
| Benzole . . . 10 " | 1,000 ccs. |

The dried and slightly warmed film is immersed bodily and hung up to dry; or it is pinned by its four corners to a board, varnish poured in a pool in the centre, and spread with a brush.

FOR WET COLLODION NEGATIVES—

- | | |
|----------------------------|------------|
| (1) Gum arabic . . . 1 oz. | 110 g. |
| Water . . . 10 " | 1,000 ccs. |
| (2) White of one egg | |
| Water . . . 20 oz. | 568 ccs. |

PRINT VARNISHES—

Prints are sometimes varnished in order to remedy the dead or sunken-in effects so common with matt surface papers. Valenta's formula is

- | | |
|----------------------------|----------|
| Benzole . . . 4 oz. | 400 ccs. |
| Sandarach . . . 1 " | 110 g. |
| Acetone . . . 4 " | 400 ccs. |
| Absolute alcohol . . . 2 " | 200 " |

BLACK VARNISH—

Bleached shellac	3 oz.	330 g.
Methylated spirit	10 „	1,000 ccs.
Aniline black (sol. in spirit)	60 grs.	14 g.

VARNISHING NEGATIVES, ETC.

The object of varnishing is to protect the gelatine film from scratches, damp, etc., and to prevent silver staining due to the absorption of damp by both papers and negatives.

Hot Process.—The negative is warmed to drive out all moisture, and then allowed to cool. The negative need not be hot when the varnish is applied; it is much more important that the negative is dry. Hot negatives may crack when cold varnish touches them, and the varnish may dry with marks and streaks, while a damp film will cause the varnish to dry milky, fish-scale markings possibly appearing later. The negative is held film side upwards in the left hand, the bottle of varnish in the right, and a pool poured into the centre of the plate and allowed to spread almost to the edges; then the negative is tilted slightly until the varnish flows to the top right-hand corner, next to the left, then to the bottom left-hand corner, and finally to the bottom right-hand corner, from which corner the superfluous varnish is poured back into the bottle, holding the corner of the negative in the mouth of the bottle, and “see-sawing” the negative to prevent streaks. The negative is next heated before a fire or over a gas-burner until the coating is hard and dry, it being kept on the move to obviate the formation of streaks.

Cold Process.—In applying cold varnishes the chief consideration is absolute dryness. The varnish is applied in the manner described for the hot process, although with care it may be brushed on sparingly with a soft brush. The negatives are set aside to dry in a place where dust cannot form on them. Films may be immersed bodily in some varnishes.

Varnish Substitutes.—Various substitutes for varnishing are known. One method is to place a very thin celluloid film between the negative and the printing paper, but this is a protection only during printing. Another method is to harden the film with tannic acid and alum.

VELVET SURFACES

The semi-glossy surfaces of some bromide and gaslight papers; practically identical with “carbon surface,” “semi-matt,” etc.

veneER, PHOTOGRAPHIC

A photographic veneer is a print fixed to transparent celluloid and applied to cabinet work.

VENICE TURPENTINE (See “Turpentine.”)**VERANT** (Fr. and Ger., *Verani*)

An optical instrument invented by Dr. Moritz von Rohr, in 1903, and used for viewing single photographs. It adopts a principle originally suggested by Prof. A. Gullstrand. It consists of an open holder for the print, and a viewing lens of such a focal length as to be practically equal to that of the objective with which the photograph was taken. The eye thus sees the print in the same manner as the camera lens viewed

the original landscape or object. The result, with a properly lit, well-modelled photograph, is almost equivalent to stereoscopic effect. The single-lens Verant is for use with one eye only, but a double pattern for viewing two similar photographs is also made.

VERASCOPE

A two-lens camera taking twelve stereoscopic or twenty-four single pictures. It may be used as a viewing apparatus for the pictures taken with it.

VERDIGRIS

Impure copper acetate.

VERRE SOUPLE

An early name for celluloid or other flexible material used instead of glass for negative making.

VERTICAL CAMERA (See “Camera, Vertical” and “Copying Stand.”)**VEST CAMERA** (See “Buttonhole, or Vest, Camera.”)**VICE, PLATE**

A wooden clamp laid on the bench for holding plates whilst being cleaned.

VICTORIA

A commercial size of portrait mount measuring about 5 in. by 3½ in.; the Victoria midget measures 2½ in. by 1½ in. These sizes are subject to slight variation.

VIEW ANGLES, TABLE OF

The following table gives the degree of angle subtended by any lens on the longer sides of various sizes of plates:—

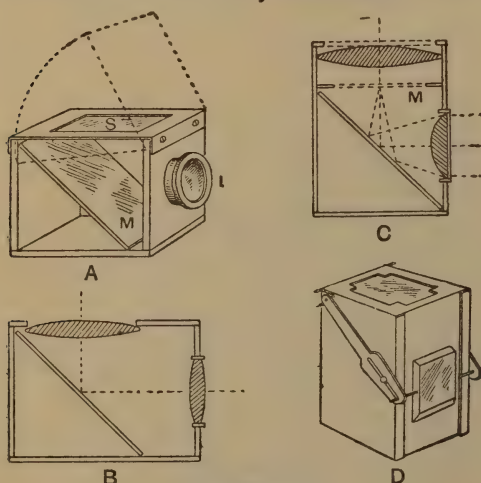
Lens Fo- cus.	Size of Plate in Inches.						
	4½ × 3½	5 × 4	6½ × 4½	8½ × 6½	9 × 7	10 × 8	12 × 10
Ins.							
3	74	79	97				
4	58	64	78				
5	48	53	62				
6	41	45	53				
7	36	39	50	81	84		
8	31	35	44	56	59		
9	28	31	40	51	53		81
10	24	28	38	46	49	79	74
11	22	26	33	42	44	71	67
12	20	24	30	39	41	58	62
13	19	22	28	36	38	53	57
14		20	26	34	36	45	53
15		19	24	32	33	42	50
16			22	30	31	39	46
17			20	28	30	37	44
18			19	26	28	35	41
19			18	25	27	33	39
20				24	25	31	37
						29	35
						28	33

VIEW FINDER (Fr., *Viseur*; Ger., *Bildsucher*, *Sucher*)

An accessory showing the amount of subject included by the lens of a camera. The commonest form A resembles a miniature camera obscura. A small convex lens L throws upon a mirror M the rays proceeding from objects in front of the camera. M is inclined at an angle of 45°, and reflects an image upon a horizontal

ground-glass screen *s*. Usually a hood shields the ground glass from extraneous light. The frame, or mask, surrounding the ground glass should be of such a size that the image contains the same amount of subject as is shown by the camera lens on the focusing screen or plate. A new finder should be tested, and if it includes too much, pencil lines should be drawn round the margins of the ground glass to exclude the surplus subject, the outer space being then blocked out with black paint. If it shows too little, a mental allowance will have to be made when exposing. With this type of finder the image is dull, due to loss of light caused by the ground glass.

In the brilliant finder *B* the ground glass is replaced by a second convex lens, which receives the rays from the mirror, forming a very bright image. The first finder of this kind was constructed by A. L. Adams and H. Hill in 1894, and there have been many modifications. Some



View Finders

patterns have a reflecting prism instead of a mirror, with one side ground to a curve to form a lens. An unfortunate peculiarity of the brilliant finder in its simplest form is that the amount of image included varies slightly according to the position of the observer's eye. This defect was overcome, in 1898, by Beck, who placed a rectangular opening or mask *M* between the two lenses at the focal distance of the first lens. (See diagram *C*.)

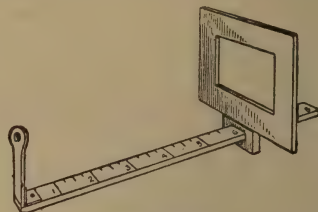
There is a growing tendency to use a finder in which the object is directly viewed. This may consist either of a small concave lens or an open wire frame with a sight. (See "Direct Finder.") A few cameras for special purposes are fitted with field-glass or telescopic finders.

Among more recent improvements in finders must be mentioned the Adams Identoscope (1905), illustrated at *D*, the front lens of which is made to move in unison with the camera lens, so that the exact effect of using the rising or falling front is immediately shown.

The reflex and twin-lens cameras have full-size finders of the camera obscura type, the camera lens itself, in the case of the reflex, serving also as the finder lens.

VIEW METER (Fr., *Chercheur*, *Iconomètre*; Ger., *Bildmesser*)

A device for showing the amount of subject which would be included on the plate if the camera were set up in a given position, thus enabling the operator to judge the best point of view without experimentally erecting the apparatus. One pattern is like a small telescope with



View Meter

a suitable mask or opening inserted to limit the view to the required proportions. Another form consists of a small rectangular frame sliding on a graduated rod, at the other end of which is a sight. (See the illustration.) The opening should be proportional to the size of plate to be used, while the distance from the sight to the opening should bear the same proportion to the focal length of the lens. Thus, for a quarter-plate camera with a lens of 6-in. focal length, the opening might be $2\frac{1}{4}$ in. by $1\frac{1}{8}$ in. and the distance of the sight 3 in. On applying the eye to the sight, the view seen through the opening is then exactly identical with that which would be included if the camera were set up with its lens in the position of the sight and pointing in the same direction. Such a view meter is readily made to fold up when not in use, and may be carried in the pocket.

By marking different distances on the rod, the finder may be made to show the view included by lenses of various focal lengths. Thus, in the foregoing example, if the frame is slid along the rod until it is 2 in. from the opening, it gives the same amount of view as a 4-in. focus lens, and so on. The open frame gives the clearest view; but, if preferred, a piece of blue glass may be fixed in or against the opening, when the subject is seen in monochrome and its photographic value is more easily judged.

VIEW POINTS

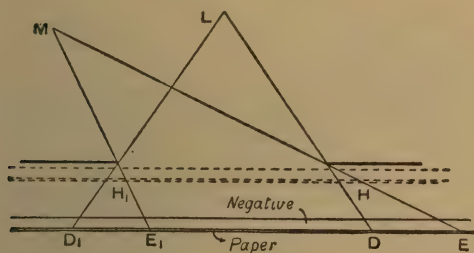
On the selection of the point of view depends the composition of the subject. A slight change in the point of view frequently results in a great change in the lines and arrangement of the subject. When the lighting is strong a still further alteration is made in the result by varying the position and direction. It should form a part of every photographer's practice to select a subject and carefully study the variations produced by examining it from every possible point of view; these should include the variations resulting from a different standpoint and those obtained by placing the camera above or below normal eye level. A striking example of wide differences in form is given by the appearance of a sailing vessel as seen broadside on, bows on, stern on, or "three-quarters." But differences almost as striking may be noted by studying

the different aspects of a cottage, or even of a landscape. In figure work, also, the many variations are obvious.

VIEWING DEVICES (See "Alethroscope," "Graphoscope," "Lanternoscope," "Neomonoscope," "Pantoscope," "Stereoscope," "Verant," etc.)

VIGNETTTERS AND VIGNETTING

A vignetted picture softens off gradually until whiteness is met with at the edges. Vignetting is believed to have been introduced in photography by Latimer Clark in 1853, and while it is invariably condemned by artistic workers, it is still popularly considered a pleasing style of finish-



Principle of Vignetting

ing for portrait heads. It is produced by allowing the centre part to print out while the edges are shielded in such a way that the light gradually decreases in actinic power as it reaches the edges. From the diagram it is seen that a vignetted contact print is produced by the diffusion of the light rays as they fall upon the negative with the sensitive paper beneath. Assuming the light rays to proceed from a source *L*, their full force acts upon the negative between *D* and *D*₁. The diffused rays from *M*, however, act upon the area *E**E*₁, and consequently the part between *D* and *E*₁ is more strongly lighted than the other parts. Also, as the light rays become more oblique, an increased amount of light is lost by means of reflection. The greater the separation, up to a certain point, between the vignetter and the negative, the more gradual will be the merging of the print into a white border. If, for example, the vignetter were lowered or the negative raised to the dotted lines shown the result in the latter case would be that the parts between *H*₁ and *H* would be printed strongly and the image would not soften off to *E* as it would do with a greater separation. In practice, it is found that $\frac{1}{4}$ in. to 1 in. is enough for a carte de visite portrait, and from 1 in. to $1\frac{1}{2}$ in. for a cabinet.

Clark, in the published account of his methods (1853), states that he used a hole cut in an opaque substance placed $\frac{1}{4}$ in. above the negative; the whole arrangement was caused to revolve by means of a bottle-jack to assist the diffusion of the light at the edges.

In 1857, Forrest, of Liverpool, introduced the stained glass vignetter, which is a piece of flashed ruby or orange glass with a colourless centre; it is usually of the same size as the negative, and is often placed in the frame with

it, but it gives softer and better results if laid on the frame in such a way as to increase the space between it and the negative; being of the same size as the negative, the separation possible is not great. The extent of the clear glass portion is fixed, and in order to do good work the photographer must have a supply of such glasses with different shapes and sizes of openings.

The iris vignetter consists of a piece of vulcanised fibre or thin wood large enough to cover the printing frame, and having a central aperture, round the edge of which is a series of riveted plates, one slightly overlapping the other. The shape and size of the opening are altered by moving the plates.

An easily made vignetter utilises a piece of card or the lid or bottom of a plate box; it must be large enough to cover the whole frame, and a hole is cut in the centre. This card is laid over the frame during printing, the separation between card and negative being such as to diffuse the light at the edges. To assist in obtaining a soft edge to the image, the edge of the card may be serrated, and small holes made around the large hole, or one, two, three, or more thicknesses of issue paper may be pasted around the edge of the hole. Of the many other kinds of vignetter only the sand vignetter need be mentioned. A lid of a plate box large enough to cover the frame is taken and the bottom of the lid cut away, leaving a narrow ledge, about $\frac{1}{4}$ in. wide, all round. A piece of plain glass is then dropped into the lid and rests upon the ledges, thus forming a glass-bottomed tray. This is laid on the printing-frame, and fine dry sand is poured into the shallow tray in such a way as to leave a clear glass centre.

Portrait heads make the most effective vignettes. Dark backgrounds should not be vignetted, neither should Rembrandt and other strongly lighted portraits. When printing vignettes, it is necessary to use diffused light and to select a spot where the light reaches the frame equally from all parts; the more slowly a vignette is printed the better and softer will be the grading, and any attempt to use strong light or direct sunlight would cause the outlines of the vignetter to show in the form of a well-defined line on the print. Should the light spread too much under the vignetting device, place loose cotton-wool between the negative and the vignetter; but this must be done with great skill, or the wool will form an outline on the print. The above remarks apply to the vignetting of prints made upon printing-out paper in diffused daylight.

The methods of vignetting given above do not give the best effects with bromide and gas-light paper, although some commercial vignettes allow of printing to be performed by artificial light almost as easily as by diffused daylight. For vignetting bromide prints or enlargements the vignetter must be moved while the exposure is being made, cut-out cards being used. A card is cut of the desired shape and size, the latter being sufficient to prevent the light creeping round the sides and causing fog in the case of enlargements. The card is held between the sensitive paper and the lens, and moved backwards and forwards in order to spread the light.

The nearer the lens the greater the diffusion, and the more of the image upon the paper. Contact bromide and gaslight prints are vignettied in the same way, except, of course, that the bromide paper is placed in a frame with the negative in the usual way and the vignetter held between the frame and the source of light. The hole in the card must be small in comparison with the size of the vignette desired, as the light spreads considerably; it is also advisable to arrange the light so that the print or enlargement takes some little time to expose, in order to give more time for effective vignetting.

In process work, half-tones are vignettied by special means. Holt's vignetter is a triangular frame supporting at its apex a clockwork movement which gives an eccentric motion to a serrated white cardboard frame, placed some distance in front of the copy and illuminated by arc lamps on the side towards the lens. The frame is set in motion during the exposure, and the effect is a darkening of the negative towards the margins. Mole's vignetter acts by chamfering the edges of the half-tone plates from underneath. A revolving cutter projects slightly through a slot in the table, and the back of the plate is pressed over it at the parts where the cutting down has to be done. The edges of the plate are then beaten down with a fibre mallet, so that they are lower than the central part; thus when the plate is mounted the edges are below the type height and print lighter.

VILLAIN'S DYE PROCESS (See "Phototincture.")

VIOLET TONES

These are invariably difficult to obtain. For toning black-and-white bromide prints to a violet colour, use:—

A. Copper chloride	. 25 grs.	5.75 g.
Water	. 5 oz.	500 ccs.
B. Ferric oxalate	. 2½ grs.	.575 g.
Potass. ferricyanide	2½ "	.575 "
Water	. 10 oz.	1,000 ccs.

To each solution add a saturated solution of ammonium carbonate until the first precipitate formed is dissolved. The bromide print is placed in B until it is a strong blue, and then in A until it appears a good violet; finally it is washed.

VIRTUAL FOCUS

An imaginary focus, or focal length, as, for example, that of a concave lens, which does not form an image.

VIRTUAL IMAGE (Fr., *Image virtuelle*; Ger., *Virtuelles Bild*)

An image formed in the air by negative lenses and used in contradistinction to the real image projected by a positive lens.

VISCOUS DEVELOPER

A developer made thick with glycerine or treacle; said by some to give greater softness, finer grain, and prevent halation to a very large extent. Treacle is the most widely recommended, a solution of equal parts of treacle and

water being used instead of plain water when preparing any developer for use.

VISION, PERSISTENCE OF (See "Kinematography.")

VISUAL FOCUS

The focus of those rays most visible to the eyes; that is, the green-yellow rays, as opposed to the focus of the blue-violet or chemical rays.

VISUAL RAYS

The luminous rays of the spectrum, by which an image is focused in the camera, as opposed to the less visible actinic or chemical rays.

VITRIOL (See "Sulphuric Acid.")

VITROTYPE

A process of producing burnt-in photographs on glass or ceramic ware and patented in 1857 by McCraw, of Edinburgh.

VOICE PHOTOGRAPHY (Fr., *La photographie de la voix*; Ger., *Stimmenphotographie*)

The photography of sound vibrations due to the voice. Various workers have experimented in this direction, among them being Czermak (1862), Blake (1878), and Hermann. The first-named secured photographs of the vocal chords in action. Prof. Blake, of Brown University, U.S., used a small mirror caused to move by the vibration of a telephone diaphragm. A beam of light was thrown on the mirror, and the movements of the latter which resulted from the use of the telephone were recorded on a photographic plate kept in regular motion by clockwork. Prof. Hermann, at an International Congress of Physiology, at Liège, demonstrated the possibility of using a microphone in connection with a phonograph to record vowel sounds. The vowels were spoken or sung into a phonograph, and the cylinder containing the reproduction was afterwards revolved very slowly before a microphone furnished with a small mirror. A beam of electric light was thrown on the mirror, which vibrated in accordance with the sound given out by the phonograph, and reflected the beam through a slit upon a revolving cylinder covered with sensitised paper.

VOLATILE ALKALI

A synonym for ammonium carbonate.

VON BENTIVEGNI'S COLOUR PROCESS

A kind of crystoleum process. The glass, with the mounted and dried print attached, is soaked in a warm mixture of castor-oil, vaseline, etc., then in castor-oil alone, and is then rubbed dry and coloured.

VULCANITE (Fr., *Vulcanite*; Ger., *Ebonit*)

India-rubber treated ("vulcanised") with sulphur in a closed furnace and obtainable in many different colours. Black vulcanite is commonly known as ebonite.

W

WARNERKE, LEON

Born in Hungary, 1837; died at Geneva, 1900. He settled in England about 1870, and was a civil engineer, but took to photographic experimenting, and contributed largely to photographic knowledge. He was well known to the photographic societies of many countries. In 1877 he was awarded a prize in Belgium for the best dry-plate process, and in 1881 the British R.P.S. Progress medal. His sensitometer numbers were used by plate makers for indicating speeds, his actinometer being introduced in 1880. As early as 1869 he experimented with other supports than glass for the sensitive film, and used Steinbach paper sized with starch, coated with collodio-bromide emulsion. At one time he used the sheets of sensitive material interleaved with orange paper in the form of a block resembling an artist's sketching block, and employed it in this form in the camera. The difficulties of using these early types of films led him, in 1875, to invent a roller dark-slide, in order that the film in a band could be wound from one roller at one end to a roller at the other. In 1885 he introduced and patented a negative paper coated on both of its sides. In 1881 he found that an exposed gelatine film developed with pyro-ammonia becomes insoluble in hot water in the parts affected by light, and that if soaked in warm water and attached to a glass plate, the paper can be stripped off and the soluble gelatine washed away, leaving a reversed negative attached to the glass.

WARNERKE'S SENSITOMETER

A sheet of glass bearing a series of numbered squares, ranging from 1 to 25, with varying quantities of opaque pigment, used for testing the sensitiveness of plates. With it was issued a plate of phosphorescent calcium sulphide or Balmain's luminous paint, which was excited with 1 in. of burning magnesium ribbon, and after the lapse of a given time (30 seconds) the plate to be tested was exposed to the luminous rays emitted by the tablet; after development the last number legible when the negative was laid against white paper was taken as the speed of the plate. It is now practically obsolete.

WARNERKE'S TISSUE

A gelatino-silver emulsion tissue used in an obsolete process of photo-engraving.

WARNER-POWRIE PROCESS

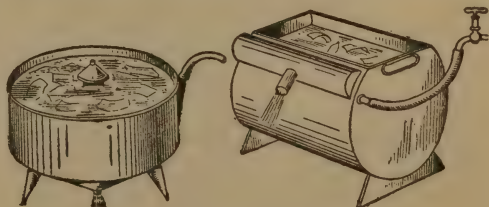
A method of producing screen-plates for colour photography based on the insolubilisation of bichromated fish-glue by the action of light, and subsequent mordanting and staining of the insoluble gelatine. The chief feature of the process is the extreme simplicity of its working, and the absence of overlap of or interspaces between

the lines. Briefly, the details of the process are as follows: A sheet of glass is coated with bichromated fish-glue and exposed under a black-and-white line screen in which the black lines are twice the width of the transparent spaces. After exposure the plate is developed in warm water, which removes the gelatine not rendered insoluble by the action of light. The insolubilised gelatine lines are then mordanted with an acid aniline dye and stained with a basic dye, the result being an insoluble, transparent precipitate of dye. The coloured lines thus produced are hardened with tannin or other agent, and the whole plate coated with bichromated fish-glue again. After drying, the original black-and-white matrix is now arranged in contact with the screen plate so as to cover all the coloured lines thereon and a second exposure made. The result is a second series of lines of insoluble colloid which may or may not be in contact with the first series. This second series is now mordanted, stained, and hardened precisely as at first. Again the plate is coated with bichromated fish-glue, and, after drying, exposed without the intervention of any screen through the back of the plate. The previously coloured lines, which should be the red and green, act as the protection for those portions of the third coating of bichromated colloid immediately over them, whereas in the interspaces, where there is no protecting colour, the bichromated colloid is rendered insoluble, and again mordanted, stained and hardened.

A more recent modification of the process is the placing of the second set of lines at right angles to the first and the subsequent filling up of the third interspace by a similar process as above outlined. This gives a screen with one set of lines and the interspaces divided up into rectangles of the two other colours.

WASHERS (Fr., *Panier-laveur*; Ger., *Positivwässerung*, *Papierwässerung*)

Vessels or appliances for washing photographic prints, usually consisting of an enamelled metal



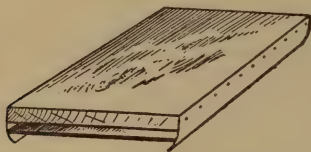
Two Forms of Washer

tank with or without a syphon outlet. They are frequently made of a circular form, or with curved sides, the water being introduced in

such a way that a rotary motion is given to the prints. The motion should not be overdone by using too violent a stream of water, or the prints may be damaged. Commonly a perforated plate is fitted near the bottom of the washer, to prevent the prints being carried away through the outlet, and to allow a more efficient separation of the "hypo." The illustrations show two typical patterns of print washer. For work on a large scale, flat dishes or tanks are usually preferred.

WASHING (Fr., *Lavage*; Ger., *Waschen, Reinigen*)

Negatives and prints that have been fixed in "hypo" must be freed of this substance by washing with water before they can be safely dried; otherwise the permanency of the result is impaired. "Hypo" being of greater specific gravity than water, it follows that as part of the washing water removes "hypo" from the gelatine and paper it becomes a solution which is denser than plain water, and therefore tends to sink to the bottom of the washing vessel. Agitation is necessary to cause the plain water and the "hypo" solution to mix thoroughly, although slight admixture must, of course, occur. It



Negative Holder for use in Washing

follows, then, that the worst method of washing is to place a negative or print film side upwards in still water, and that the quickest and best way is to support the film in such a way that the "hypo" may, as it were, fall out of the film to the bottom of the vessel. For washing a single negative quickly, it may be held in the hand, face downwards in a pail of water, where it will be freed from "hypo" much more quickly than if laid in a dish and water allowed to run upon it. A convenient accessory for holding a negative film side downwards is shown. To a piece of wood the same size as the negative are nailed strips of tin-plate, as shown, these being bent under so as to hold the negative. The last named is slid into place, film side outwards, and the whole floated in a vessel of water; in this way the suspending of a negative film side downwards in water becomes a very simple matter. Another method is to use a dish with sloping sides, which support the negative when this is placed horizontally. Most of the commercial washers hold the negatives in a vertical position, in which position they wash quickly and well if space is left below the negatives. When a negative is held vertically, the "hypo" solution flows to the lower edge and congregates in a dense mass at the bottom of the vessel; this demonstrates the necessity of having a space below the negative if still water is used. The propping up of a negative on a brick placed in a pail of still water is a simple method of washing when running water is not available, as by

frequent changes the "hypo" may be quickly got rid of.

The time taken to wash a negative or print depends upon the method employed and upon other considerations. Several experimenters, after exhaustive trials, have stated that a washing of twenty minutes is enough for negatives under favourable conditions. Complete removal of "hypo" from negatives occupies about twice the time the plates take to fix, in favourable circumstances. Negatives do not hold "hypo" as prints do, as in the latter there is the porous paper to consider. Lumière and Seyewetz concluded that the use of running water for washing was both wasteful and inefficient, and that the best way to wash negatives is to immerse each negative, vertically or upside down, in five successive baths for five minutes each (twenty-five minutes in all), allowing 17 oz. of water to each half-plate. Gaedicke discovered a number of useful facts, the most important of which is that when the water is changed every five minutes, three times as much "hypo" is extracted as when the water is changed every half-hour.

As regards the washing of prints, practically all the above remarks apply. Prints and celluloid films should be kept on the move and the water frequently changed or carried away from the bottom of the tank. If they are soaked in still water, this must be frequently changed, or the prints should be transferred from one dish to another. From data published by Messrs. Lumière, it seems that eight changes, using 3½ oz. of water for each 7-in. by 5-in. print, are sufficient; 90 per cent. of the "hypo" is soaked out by the first two baths. In the case of a print placed for twenty minutes under a tap passing about 14 pints per minute, and then allowing it to soak for five minutes in 3½ oz. of water, the latter was found to contain about the same quantity of "hypo" as the water after one-fifth the washing in the manner above described. The experimenters state, however, that these methods do not remove the last minute traces of "hypo," and that even twenty-four hours in running water will not do it. Haddon and Grundy stated in 1894 that they had proved that gelatino-chloride prints, washed for ten minutes in running water and under proper conditions, had lost the whole of the soluble salts, and that there was no necessity whatever to wash longer; further, they also found that six changes of water after five minutes' soaking were equally effective. Thus it is obvious that the amount of washing necessary for both negatives and prints depends entirely upon the conditions under which they are washed, no two experimenters agreeing.

For methods of testing washing water for "hypo," see "Sodium Hyposulphite, Testing for."

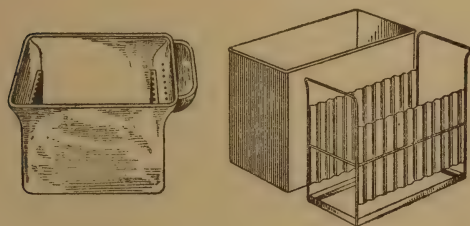
WASHING EMULSION (See "Emulsion.")

WASHING SODA (See "Sodium Carbonate.")

WASHING TANK (Fr., *Cuve à lavage, Cuve à rainures*; Ger., *Wässerungskasten*)

Tanks for washing negatives are generally of metal or porcelain, with grooves at the sides.

They should be furnished with syphons to empty off all the water from the bottom when it reaches a certain height; otherwise the current from the tap will merely run over the top of the full tank, and the water in the latter will not get changed. A shows a porcelain washing trough of practical



A. Porcelain Trough

B. Metal Tank

design. Metal tanks are frequently fitted with a removable rack, as shown at B, which serves for drying the negatives after they are washed. (For print washers, see "Washers.")

WASHINGS (See "Residues.")

WASH-OUT GELATINE PROCESS

A modification of the swelled-gelatine process for the production of photo reliefs. The unexposed parts of the image were washed away, instead of being swelled up, and a plaster cast was taken from the relief. Ultimately, either a stereotype or electrotype was made from the cast.

WASTES (See "Residues.")

WATCH CAMERA (Fr., *Chambre montre*; Ger., *Uhrkamera*)

Various cameras have been made in the form of a watch. In one, a series of telescopic metal tubes forming the body sprang out into position on pressing a spring. A more recent form of watch camera, the "Ticka" introduced in 1906, takes roll-films, twenty-five negatives the size of a postage stamp being obtained. Owing to its short focus, the depth of definition is great, and the small negatives will stand enlarging to $3\frac{1}{4}$ in. by $2\frac{1}{4}$ in., or even larger.

WATCH-DIAL PHOTOGRAPHS

A miniature of the portrait is taken by the collodion emulsion process, transferred to the dial, and varnished over. Similar results have been obtained by the carbon process. If the collodion film is toned with platinum, the image may be fired and burnt into the enamel.

WATER (Fr., *Eau*; Ger., *Wasser*)

Ordinary tap-water usually contains chlorides, sulphates and earthy salts, which, by causing precipitates, may give rise to trouble, particularly in the case of developers. All tap-water contains carbonic acid and oxygen, which tend to discolour the developing agent. Distilled water can be obtained very cheaply. In any case, ordinary water should be well boiled, allowed to cool, and filtered before use. For all solutions of the noble metals, platinum, gold and silver, distilled water is an absolute necessity. (See also "Distilled Water.")

WATER LENSES (See "Fluid Lens.")

WATER-DEVELOPED PLATES (See "Self-developing Plates.")

WATERFALLS, PHOTOGRAPHING

The strong contrast between the bright water and the dark foliage or rocks surrounding it make the photographing of waterfalls somewhat difficult. If the quality, the sparkle, and the movement of the water are to be retained, a very short exposure is necessary; and such an exposure cannot be expected to secure detail and gradation in the surroundings at the same time. On the other hand, if an exposure is given to render the setting properly the water will lose its texture and become woolly or streaky. Sometimes, with a very fast plate and a large lens aperture a compromise may be arrived at, and the whole subject be properly rendered on one plate. The effect may be further improved by shielding the dark portions (light portions of the negative) with paper or matt varnish, and so allowing the denser water to print out more fully.

When this is not feasible, it is well to make two exposures, timing one for the moving water and the other for the surroundings. Each negative is then masked so that one prints only the water, the other the setting.

WATER-GLASS (See "Potassium Silicate" and "Sodium Silicate.")

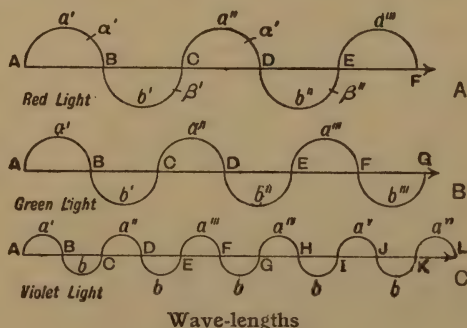
WATERHOUSE STOPS (See "Diaphragms.")

WATERPROOF PAPER

Waterproof paper is used for mounting and wrapping up chemicals and sensitive material. A serviceable waterproof paper may be made by brushing a strong solution of Castile soap over some paper, and when nearly dry brushing over with a strong solution of chrome alum. This method of waterproofing answers well for fabrics generally.

WAVE-LENGTHS (Fr., *Longueurs des ondes*; Ger., *Wellenlängen*)

Light is considered to be an undulatory or wave-like motion in the ether, and the conventional figures used to illustrate this are the following:—



Assume that the light is travelling from left to right in each of the above figures, A, B, and C; the ether particles vibrate to and fro, and

each excites its neighbour till the motion reaches the maximum of the crest of the wave at A, and then it vibrates in the contrary direction till it reaches the maximum of the trough at B, each ether particle merely moving to and fro between the planes bounding A and B. Now, a wave length is the distance from any two points in the same phase of movement, such as A and C, C and E, B and D, and D and F. These points have been taken on the axis of the direction of the propagation of light, but any two other points could be measured from, such as A' and A'' or a' and a'', or β and β'' , or b' and b'' . If the distance AC is a wave length, AB or BC is exactly half a wave length, and so on; further, the length of the wave A to C in a red light is double that of C, the violet A to C, whilst in B green light, the length is midway between them. The wave length of any pure spectrum is always constant, no matter what the source of light; and it could be used as a definite standard of colour; and it is by no means uncommon to see the expression that a colour is that of $D \frac{1}{2} E$; that is to say, a colour can be matched by the spectrum ray, which lies exactly midway between the solar Fraunhofer lines D and E.

There are several units of measurement or methods of writing the wave-length, which is usually abbreviated to λ . The unit most generally adopted is the tenth-metre = 1×10^{10} metre or the ten-millionth of a millimetre, which was the unit adopted by the great Swedish physicist Angström, one of the first to give a reliable map of the solar spectrum, and this is then abbreviated to A.U. (Angström's Unit) or t.m. It may also be expressed in millionths of a millimetre, called a milli-micron, and written $\mu\mu$, or in thousandths of a millimetre, called a micron, and written μ ; or it is also written as a ten-thousandth of a centimetre or 10^6 cm. So that we might describe the D_1 line as—

$\lambda \ 589616 \times 10^6 \text{ cm.} = \cdot 0000589616 \text{ cm.}$
 or $\lambda \ 0\cdot589616 \ \mu$
 or $\lambda \ 589\cdot616 \ \mu\mu$,
 or $\lambda \ 5896\cdot16 \text{ A.U. or t.m.}$

For all methods for measuring wave-lengths, except rough visual work, that of photographic coincidence is usually adopted.

WAX (See "Beeswax" and "Paraffin.")

WAX ENGRAVING

Synonym, cerography. A brass plate is cleaned, then blackened by flowing with a solution of silver nitrate 10 g., water 250 g., and nitric acid 2 drops. It is rinsed, dried, warmed, and covered with a mixture of paraffin-wax and white pigment such as zinc white. When cool, an outline tracing is set-off on to the surface with red chalk, and the lines of the design are scratched through the film. For map work, the names are pressed into the wax with heated metal type. Finally, the large whites are built up with wax run off a hot tool, and the surface is made conductive with blacklead. Then the plate is used as a mould for electro-deposition.

WAX PROCESS

A general term for reproduction processes in which wax is used; in particular, wax engraving.

WAXED-PAPER PROCESS

A modification of the calotype process introduced, in 1855, by Le Gray. The wax was used in order to prevent the grain showing, and also to stop up the pores of the paper. The original process was, briefly, as follows: A suitable paper was placed on a heated silvered copper plate, and pure white wax rubbed well into it; it was ironed between sheets of blotting-paper. For preparing the iodising solution, rice was soaked in distilled water. To a little less than a quart of the rice water 620 grs. of sugar of milk, 225 grs. of potassium iodide, 12 grs. of potassium cyanide, and 7 grs. of potassium fluoride were added, and the waxed paper was soaked therein for about an hour and dried. The paper was then sensitised by floating for four or five minutes on a bath made by dissolving 78 grs. of silver nitrate in 2,325 grs. of distilled water, and then adding 186 grs. of crystallised acetic acid; for portrait work, however, Le Gray advised 155 grs. of silver nitrate. The paper was then dried in the dark and exposed in the camera, the exposure being from twenty seconds to fifteen minutes. It was developed by immersing in a solution of gallic acid ($1\frac{1}{2}$ grs. to the 1 oz.).

WAXING

Wax is applied to paper negatives in order to make them more translucent, and to facilitate printing.

WEATHER PICTURES (See "Barometer, Photographic.")

WEDGWOOD, THOMAS

Born 1771, died 1805. Third son of Josiah Wedgwood, the potter. He studied the action of light upon certain compounds of silver, and in 1795 obtained "sun pictures" by placing more or less opaque objects upon paper and white leather coated with a weak solution of silver nitrate.

WEIGHTS AND MEASURES

Recognised abbreviations are: Pounds, lb.; ounces, oz. or $\bar{z}$; drams, drs., drms., or $\bar{s}$; scruples, sc. or $\bar{r}$; grains, grs.; pints, pt.; minims, mins.; pennyweights, dwt. The only metric abbreviations of interest are: gramme, g.; cubic centimetres, ccs.; millimetres, mm.; centimetre, cm.

The grain has the same value in apothecaries', avoirdupois, and troy weight.

Apothecaries' Weight

(Formulae are made up by this weight.)

lb.	oz.	drms.	sc.	grs.	(METRIC.) grammes.
1	12	96	288	5,760	373.276
	1	8	24	480	31.106
		1	3	60	3.887
			1	20	1.296
				1	0.0648

Fluid Measure

Pt.	oz.	drms.	mins	(METRIC.) ccs.
1 (American)	16	128	7,680	454.4
1 (English)	20	160	9,600	568
	1	8	480	28.4
		1	60	3.5
			1	0.058

The fluid pound = 12 oz. = 5,760 mins. = 340.8 ccs.
 The fluid ounce of water weighs 437.1 grs. = 28.4 g.

Avoirdupois Weight

(Most chemicals are sold by this weight.)

lb.	oz.	drms.	grs.	(METRIC.)
1	16	256	7,000	grams.
	1	16	437½	28·4
		1	27½	17·7

Troy Weight

(Gold, silver, etc., are sold by this weight.)

lb.	oz.	dwt.	grs.	(METRIC.)
1	12	240	5,760	grammes.
	1	20	480	31·1
		1	24	1·55
			1	0·6

Grains to Grammes

Odd numbers may be found by simple addition.

grs.	g.	grs.	g.	grs.	g.
1 equals	0·065	12 equals	0·775	55 equals	3·564
2 "	0·13	15 "	0·972	60 "	3·888
3 "	0·194	18 "	1·166	65 "	4·212
4 "	0·259	20 "	1·296	70 "	4·536
5 "	0·324	25 "	1·620	75 "	4·860
6 "	0·389	30 "	1·944	80 "	5·184
7 "	0·454	35 "	2·268	85 "	5·508
8 "	0·518	40 "	2·592	90 "	5·832
9 "	0·584	45 "	2·916	95 "	6·156
10 "	0·648	50 "	3·240	100 "	6·480

Ounces (Apothecaries') to Grammes

oz.	g.	oz.	g.	oz.	g.
1 equals	7·776	2 equals	62·212	6 equals	186·636
½ "	15·553	3 "	93·318	7 "	217·742
¼ "	23·329	4 "	124·424	8 "	248·848
⅓ "	31·106	5 "	155·530	9 "	279·954
				10 "	311·06

Fluid Measure to ccs.

mins.	ccs.	drms.	ccs.	oz.	ccs.
5 equals	0·3	1 equals	3·55	1 equals	28·41
10 "	0·6	2 "	7·10	2 "	56·8
15 "	0·9	3 "	10·65	3 "	85·2
20 "	1·2	4 "	14·20	4 "	113·6
25 "	1·4	5 "	17·75	5 "	142·0
30 "	1·78	6 "	21·30	6 "	170·4
60 "	3·55	7 "	24·86	7 "	208·8
		8 "	28·40	8 "	237·2

Inches to Millimetres

in.	mm.	in.	mm.	in.	mm.
1 equals	25·4	1 equals	15·9	1 equals	25·4
½ "	12·7	½ "	12·7	½ "	12·7
⅓ "	16·0	⅓ "	11·1	⅓ "	8·3
¼ "	20·16	¼ "	9·5	¼ "	6·4
⅕ "	25·4	⅕ "	8·7	⅕ "	5·6
⅙ "	31·75	⅙ "	7·9	⅙ "	4·8
⅛ "	31·75	⅛ "	7·9	⅛ "	3·2
				⅜ "	2·4
				½ "	1·6
				¾ "	0·8

Grammes to Grains

g.	grs.	g.	grs.	g.	grs.
1 equals	15·4	11 equals	169·4	20 equals	308
2 "	30·8	12 "	184·8	30 "	462
3 "	46·4	13 "	200·2	40 "	616
4 "	61·6	14 "	215·6	50 "	770
5 "	77	15 "	231	60 "	924
6 "	92·4	16 "	246·4	70 "	1,078
7 "	107·8	17 "	261·8	80 "	1,232
8 "	123·2	18 "	277·2	90 "	1,386
9 "	138·6	19 "	292·6	100 "	1,540
10 "	154				

Cubic Centimetres (ccs.) to Minims

ccs.	mins.	ccs.	mins.	ccs.	mins.
1 equals	17	8 equals	136	50 equals	850
2 "	34	9 "	153	60 "	1,020
3 "	51	10 "	170	70 "	1,190
4 "	68	20 "	340	80 "	1,360
5 "	85	30 "	510	90 "	1,530
6 "	102	40 "	680	100 "	1,700
7 "	119				

Millimetres to Inches

mm.	in.	mm.	in.	mm.	in.
1 equals	0·04	10 equals	0·39	19 equals	0·75
2 "	0·08	11 "	0·43	20 "	0·79
3 "	0·12	12 "	0·47	21 "	0·83
4 "	0·16	13 "	0·51	22 "	0·87
5 "	0·20	14 "	0·55	23 "	0·90
6 "	0·24	15 "	0·59	24 "	0·94
7 "	0·28	16 "	0·63	25 "	0·98
8 "	0·31	17 "	0·67	25·4 "	1·0
9 "	0·36	18 "	0·71		

Rules for Conversions

Inches to centimetres: multiply by 2·54; approx., multiply by 5 and divide by 2.

Centimetres to inches: divide by 2·54; approx., multiply by 2 and divide by 5.

Inches to millimetres: multiply by 25·4; approx., multiply by 100 and divide by 4.

Millimetres to inches: divide by 25·4; approx., multiply by 4 and divide by 100.

Ounces (fluid) to cubic centimetres: multiply by 28·3.

Cubic centimetres to ounces (fluid): divide by 28·3.

Litres to pints: multiply by 1·76; approx., multiply by 7 and divide by 4.

Pints to litres: divide by 1·76; approx., multiply by 4 and divide by 7.

Grains to grammes: divide by 15·43.

Grammes to grains: multiply by 15·43.

Ounces (avoir.) to grammes: multiply by 28·4.

Grammes to ounces (avoir.): divide by 28·4.

Ounces (apoth.) to grammes: multiply by 31·1.

Grammes to ounces (apoth.): divide by 31·1.

The standard method of presenting formulæ in the metric system is to make the quantity of water equal 1,000 ccs., as in the majority of cases throughout this work. The following (merely approximate) table makes such conversions easy. For example, "hypo," 1 oz.; water 9 oz. becomes "hypo" 122 g.; water, 1,000 ccs. By a simple proportion sum this table can be used for converting metric formulæ to British:—

If 1 oz. (fl.) becomes 1,000 ccs., 1 oz. (apoth.) becomes 1,100 g.

2	"	"	"	1	"	"	550
3	"	"	"	1	"	"	367
4	"	"	"	1	"	"	275
5	"	"	"	1	"	"	220
6	"	"	"	1	"	"	183
7	"	"	"	1	"	"	157
8	"	"	"	1	"	"	138
9	"	"	"	1	"	"	122
10	"	"	"	1	"	"	110
15	"	"	"	1	"	"	73
20	"	"	"	1	"	"	55

Metric System

Proportion	Length		Capacity		Weight	
Unit	Metre	39·37 in.	Litre	35 oz. 94 mins.	Gramme	15·43 grs.
1/1000 part	Millimetre	0·039 "	Millilitre or cubic centimetre	17 "	Milligramme	0·01543 grs.
1/100 "	Centimetre	0·394 "	Centilitre	170 "	Centigramme	0·1543 grs.
1/10 "	Decimetre	3·94 "	Decilitre	3 oz. 250 "	Decigramme	1·543 grs.

"Deka" = 10 (dekametre = 10 m., etc.); "hecto" = 100 (hectolitre = 100 l., etc.); "kilo" = 1,000 (kilogramme = 1,000 g., etc.); and "myria" = 10,000 (myriametre = 10,000 m., etc.)

WELLINGTON'S SILVER INTENSIFIER

Wellington's original formula (1889) is given under the heading "Silver Intensifier." In July, 1911, Wellington published particulars of an improved process which does not stain or dissolve the film of some plates, as the original is said to do. The film is first hardened with formaline (1 part to 10 of water for five minutes), rinsed and immersed for one minute in the following: a solution of potassium bichromate, $\frac{1}{2}$ gr.; potassium bromide, 10 grs.; hydrochloric acid, 30 mins.; and water, 10 oz. Too long an immersion causes the image to bleach, and must be avoided. The intensifier is in the form of two stock solutions, both of which will keep good for years:—

A. Silver nitrate . . .	400 grs.	92 g.
Water (distilled) to . .	10 oz.	1,000 ccs.
B. Potass. sulphocyanide .	700 grs.	161 g.
"Hypo"	700 "	161 "
Water to	10 oz.	1,000 ccs.

Take $\frac{1}{2}$ oz. of B, and add $\frac{1}{2}$ oz. of A, stirring vigorously with a glass rod; the result should be a clear solution. Add 60 mins. of a 10 per cent. solution of pyro preserved with sulphite, and 120 mins. of a 10 per cent. solution of ammonia.

The solution given above is poured over the negative. The deposition of silver begins to take place in a minute or two, and the image gains in strength. When dense enough, the negative is placed in an acid fixing bath until the slight pyro stain is removed, and is then well washed. The image can be reduced with the ferricyanide-"hypo" reducer.

WET NEGATIVES, PRINTING FROM (See "Quick Prints from Wet Negatives.")

WET COLLODION PROCESS (See "Collodion Process (Wet), or Wet-plate Process.")

WHEATSTONE, CHARLES

Born 1802, died 1875. Professor of experimental philosophy at King's College, London. He invented the stereoscope in 1838, his paper on binocular vision being read at the Royal Society on June 21, when the instrument was first exhibited.

WHEY PROCESS (Fr., *Procédé à petit-lait*; Ger., *Molken Prozess*)

An early iodo-bromide enlarging process, used with the solar camera. Paper was floated on:—

Potassium iodide . . .	88 grs.	20 g.
Potassium bromide . .	44 "	10 "
Milk whey (filtered) . .	10 oz.	1,000 ccs.

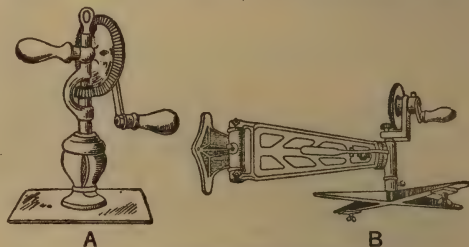
for from two to three minutes and hung up to dry. It was then sensitised with silver nitrate, exposed for from ten to sixty seconds and developed with pyro.

WHIRLER (Fr., *Tournette*; Ger., *Schleuderapparat*)

An appliance for rapidly drying glass or metal plates to which a sensitive coating has been applied, and for securing an evenly distributed film. It is principally used in photo-mechanical processes. The pneumatic whirler A has a rubber

bulb, which is simply pressed against the plate to be coated, holding it firmly by suction. The whirler is then turned upward, and the sensitising mixture, as, for example, the fish-glue solution used in the enamel process of half-tone, is poured in the centre of the plate until the pool covers about three-fourths of the surface. The whirler is now reversed, so that the plate is face downward, and revolved at a moderate speed by turning the handle at the side, holding it meanwhile over a sink until the surplus solution ceases to be thrown off. The whirler is finally held over a gas burner, still face down, and the revolution continued till the plate is dry.

Another type of whirler, invented by Max Levy and employed in process work, is shown at B. This is supported by a bracket, which may be fastened to a wall. The adjustable jaws which hold the plate can be turned upward for coating; then, when ready, a lever is pressed and the plate holder is turned down for whirling, a stove being placed beneath and a metal casing built round to receive the splashing. Or, if



Two Types of Whirler

preferred, the whirler may be fixed over a tub and then swung from the latter over a gas burner for drying. For lithographic stones and thick heavy plates a fixed whirler with a circular turntable is used.

WHITE LAC (See "Gums and Resins.")

WHITE, PERMANENT (See "Barium Sulphate.")

WHITE WAX (See "Beeswax.")

WHITENED CAMERA

An old French idea for whitening the interior of the camera with the object of reflecting some light on to the plate to reduce harsh contrasts. It has somewhat the same effect as giving a preliminary exposure to white paper.

WHOLE-PLATE

A commercial size of camera, plate, paper, etc., measuring $8\frac{1}{2}$ by $6\frac{1}{2}$ in.; sometimes written "1/1." (See also "Sizes of Plates and Papers.")

WIDE-ANGLE LENS

A lens of short focal length, including, even at close quarters, a wide angle of field or of view, and therefore frequently of great advantage in general photography. (See also "Angle of Field or of View.")

WILDE'S RESTRAINER

A solution of 19 grs. of iodine in 200 mins. of alcohol, afterwards adding 200 mins. of water,

From 2 to 4 drops is added to 1 oz. of ferrous oxalate developer.

WILLIS'S PROCESS (See "Aniline Process.")

WINDOW, BLOCKING UP

The best way of blocking up a window when the room is to be used for developing or similar work, is to make a light wooden frame to fit inside the beading of the window-frame, and over this to paste or glue two thicknesses of ruby fabric or paper. If artificial light is to be used for working, as is preferable owing to its uniformity, two thicknesses of stout brown paper will serve the purpose. The advantage of the wooden frame is that it can be instantly removed; otherwise the fabric is secured round the window itself.

WINDOW TRANSPARENCIES

In the production of transparencies upon glass or paper for window decoration, specially prepared plates are generally used, these being made and used exactly like lantern slides. If made upon glass in which the high lights are represented as clear glass, it is advisable to bind the transparency up in contact with a piece of finely ground glass or thin opal glass in order that the view outside the window may not be seen through the clear glass parts of the transparency. Coating the plain glass side with a matt varnish, tinted if required, has the same effect, and allows of obtaining good results in one or more colours. Certain plates ("matt ground" or "M.G.") have a matt surface and obviate the use of additional ground glass, but the film side should be protected with plain glass.

Window transparencies may be made from any paper prints, but the blue-prints and platinotype prints are considered the best. The print is made darker than usual, finished and finally made translucent by oiling or waxing. Platinotype prints on thin paper answer admirably without waxing, as do also blue-prints on tracing paper sensitised on one side only. Paper prints should be bound up between glass, with strips of paper or linen round the edges.

WINE, SPIRIT OF (See "Alcohol.")

WOLLASTON AND FRAUNHOFER LINES
(See "Fraunhofer Lines.")

WOOD, PHOTOGRAPHS ON

Photography on wood as a guide to the engraver was extensively practised when wood engraving was at its height of popularity. One of the simplest methods is to prepare the surface of the boxwood with a mixture of gum and zinc-white, then to coat it with albumen mixed with ammonium chloride; and after drying and waterproofing the sides of the block with wax to dip the surface into a silver nitrate bath. The surface is then dried and exposed under a negative until an image is obtained like the ordinary albumen silver print. Fixing with "hypo," rinsing, and drying complete the operation. Care has to be taken not to get the body of the wood block wet. An improvement on this is to coat the albumenised surface with iodised collodion, thinned down considerably; then to sensitise in a silver bath and print as before. After

developing and fixing, the block is dried off and is ready for engraving.

Various processes of toning with gold, etc., have been used for strengthening the image.

WOOD NAPHTHA, OR WOOD SPIRIT
(See "Alcohol.")

WOODBURY, WALTER BENTLEY

Born at Manchester, 1834; died at Margate, 1885. Inventor of the Woodburytype process, which he first demonstrated in London in 1865, and patented the following year. He went to the Australian gold fields in 1849, and four years later became a professional photographer there. In 1859 he went to Java, where he did much photographic work, returning to England and settling in Birmingham in 1863. Between 1864 and 1884 he took out twenty patents for improvements in photographic apparatus and for photo-mechanical processes.

WOODBURYTYPE

A photo-mechanical process invented by Mr. W. B. Woodbury in 1865, and patented by him on July 24, 1866. A relief image is obtained on bichromated gelatine, covered with lead, and the two forced together in a hydraulic press, which produces a reverse or mould in the lead. The mould is then inked with pigmented gelatine and printed from under pressure. A modification of the process was afterwards published under the name of "Stannotype," in which no hydraulic process was necessary. Woodburytype is quite unlike any other process in its working details, which, based on the inventor's own words, are as follow: The production of pictures, either on white paper, upon glass as transparencies, opal, etc., by this method of printing is based on the principle that layers of any semi-transparent material seen against a light ground produce different degrees of light and shade, according to their thickness, as the carbon process, for example. Therefore, by having a mould in intaglio produced by the action of light upon bichromated gelatine, and filling the intaglio so produced with a semi-transparent material, there is obtained a mould in which the parts that are the thickest give a dark colour; while the thinner the layer becomes it gradually merges into white. By pouring a mixture of coloured gelatine on to the intaglio mould, and placing a piece of white paper thereon, and squeezing the whole between two perfectly true planes, the superfluous colour is squeezed out, and the gelatine, having set, adheres to the paper and leaves the mould quite clean. When the picture leaves the mould it is in slight relief, but during drying the gelatine contracts and leaves hardly any perceptible relief. To make the gelatine relief, wet several pieces of talc, and affix them to a large sheet of glass; squeeze out the superfluous moisture, and polish the whole of the pieces. Next prepare the bichromatised gelatine as follows:—Soak 4 oz. of opaque gelatine in 28 oz. of water; dissolve by heat, clarify with white of egg, and filter. To 4 oz. of this solution add 60 grs. of ammonium bichromate dissolved in $\frac{1}{2}$ oz. of warm water and a small quantity of Prussian blue; the latter serves to give the finished relief

a colour by which to judge of its printing qualities, and does not interfere with the action of the light in penetrating the gelatine. When well mixed, the solution is filtered through muslin, and is then ready for coating upon the talc-covered glass, placed upon a levelling stand, and dried. When set, each piece of talc is cut round the edges with a sharp knife and stripped from the glass. Lay the sensitised talc upon blotting paper and clean the talc side; then place in contact with the negative, and having placed a piece of glass behind, fasten all together with rubber bands, and place in the light of a condenser of 6 in. to 9 in. in diameter, at a distance of about 2 ft.; after exposing for 1 or 2 hours lay in a dish, and pour hot water over it until no soluble gelatine is left; then allow to dry by gentle heat. Having obtained the relief, it is ready for taking the mould.

The above is Woodbury's original process. A later method of making the relief plate is to clean sheets of plate glass with French chalk and coat with collodion. When dry, the sensitive mixture, made as follows, is poured on, and laid on a level place to set:—Sheet gelatine, $1\frac{3}{4}$ oz.; glycerine, 50 drops; sugar, $\frac{1}{2}$ oz.; Indian ink, 1 gr.; carbolic acid, 1 drop; ammonium bichromate, 150 grs.; liquor ammoniæ, $\frac{1}{2}$ drm.; water, 6 oz. The gelatine is soaked in three-fourths of the water, melted by heat, and the glycerine, sugar, carbolic acid, and ammonia added. The Indian ink is dissolved in the remaining water, and added gradually, and the bichromate, well powdered, stirred in. Exposure and development are the same as for carbon printing, hot water at a temperature of 110°F . (43°C .) being used to begin with, afterwards raising it to 160°F . (71°C .). Development—that is, the dissolving away of the unacted-upon bichromated gelatine—may take two hours or longer, but the process must not be hurried. When the image is developed, it is immersed in a 4 per cent. solution of chrome alum for a few minutes, washed, soaked in methylated spirit for an hour, and then dried.

Several other formulæ for making the necessary relief from the negative have been recommended, but all except one are based on the above. The exception is the use of a modern dry plate. The plate should be of the thickly coated variety; it is printed from in contact with the original negative, a full exposure being given, and developed with the following solutions:—No. 1: Pyrogalllic acid, 30 grs.; water, 5 oz. No. 2: Sodium sulphite, $\frac{1}{4}$ oz.; potass. hydrate, $\frac{1}{4}$ oz.; water, 2 oz. No. 3: Potassium bromide, 60 grs.; water, 1 oz. For use, take $1\frac{1}{2}$ oz. of No. 1 and $\frac{1}{2}$ oz. of No. 2; develop the plate until all details are out, then add about 20 drops of No. 3 and continue development until dense enough. Place in a 10 per cent. solution of chrome alum warmed to 95°F . (35°C .), and brush the surface while under the solution with a camel-hair brush, allow to remain until in good relief, then wash well, fix in "hypo," and again wash well. It is absolutely essential that the dry plate is very thickly coated, and should there be any tendency to frill, this may be avoided by coating the edges with india-rubber solution. The dry plate process is the least satisfactory.

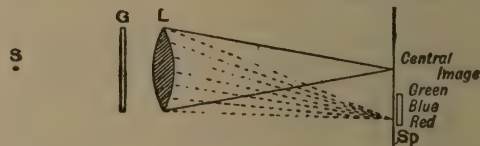
The metal mould has now to be made from

the relief. Woodbury in his early experiments used the electrotype process to obtain an intaglio from the gelatine relief, but found that for practical purposes it was impossible to obtain uniform results. Soft metal (a mixture of lead and type metal) was found by him to be better. A sheet of the soft metal is placed in contact with the gelatine relief, then both in between two perfectly true plates of steel; a pressure of 50 to 200 tons is applied, according to size, 4 tons to the sq. in. being about the pressure necessary. The gelatine film is not damaged as might be supposed, and the result is a perfectly sharp intaglio in about one minute, and the same relief will serve for several moulds. Before taking the mould, however, the film or talc containing the relief image must be stripped from the plate and used with the metal, as the enormous pressure would break the glass support, and for this reason the talc support, as advocated originally, will be found the most convenient, even if more difficult to prepare. The mould is placed in a press, and oiled slightly with a mixture of equal parts of olive and paraffin oils, and the mixture of gelatine and ink poured on. A suitable ink is made by dissolving 4 oz. of gelatine in about 25 oz. to 30 oz. of water, and then adding Indian ink, etc., the whole being kept at about 126°F . (52°C .). When the mould is covered with the ink, the paper to receive the picture is placed upon it, then a sheet of plate glass and pressure applied. The superfluous ink is forced out at the sides by the pressure, while that in the mould adheres to the paper and forms the image. After the gelatine has set, the glass plate and the paper are lifted off, and the image thereon placed in a weak solution of alum to harden.

The modified process needing no great pressure consists in making the gelatine relief in any of the ways named above; it is then, without stripping from the glass, covered with tinfoil and passed between rubber rollers. This presses the tinfoil into the interstices of the relief, producing a perfect counterpart. Copper is then electrically deposited on the tinfoil for the purpose of strengthening it.

WOOD'S DIFFRACTION GRATING PROCESS

This is practically a modification of the three-colour process in which diffraction gratings ruled with a varying number of lines to the inch are used instead of the three stained filters, and the principle of the process can be easily grasped from the following explanation. In the diagram



Use of Diffraction Grating

s is an intense source of light; between it and a lens L, is a diffraction grating G. There will be obtained not only the central white image, as indicated, but also on both sides a spectrum, and for the moment only consider the one spectrum, s p. Now, if we make an aperture in a

card at the point where red falls, and place the eye there, we shall see red only. If we replace the grating by one with finer rulings, then we shall find the green fall in the place of the red, and if we use a finer grating still, we should find there the blue. Now, if we put the two first gratings in front of the lens and overlapping one another, the red and green would fall on the aperture in the screen, and this would give us the sensation of yellow. If the third grating be added, then we should have red, green and blue light reaching the eye, and the result would be white.

The gratings used should have 2,000, 2,400 and 2,700 lines to the inch respectively for red, green and blue light to fall in the same spot. To produce a picture in colours, three negatives are taken in the usual manner through red, green and blue-violet screens as in ordinary three-colour work, and from these positives are made. A sheet of thin patent plate should be flowed over with the following:—

Gelatine	384 grs.	40 g.
Potassium bichromate (sat. sol.)	154–226 mins.	16–24 ccs.
Distilled water to	20 oz.	1,000 „

Filter whilst warm and allow the glass to drain for about 10 seconds, and then set on a level slab to dry. The sensitised glass is placed in contact with one of the three positives. The two plates should be held up in front of a lamp and register marks made on the glass surface of the sensitised plate, using minute ink dots and some prominent object that appears in all three pictures. Corresponding ink dots should now be made on the film side of the sensitised plate and the others rubbed off.

Then the grating with the coarsest ruling, which furnishes the red light, should be placed on the sensitised plate and on this the positive of the red light sensation. The lines of the grating should be vertical and the ink dots made to carefully register with the object in the positive. Expose the plates to sunlight for about 30 seconds, gripping them tightly in the fingers and holding them perpendicularly to the sun's rays. It is advisable to do this in a darkened room, using only a narrow beam of sunlight. The exposure will be about 30 seconds. Now remove the positive and grating, and substitute those for the green picture and repeat the operation, and finally, repeat the operation for the blue picture. Or preferably wash the plate in warm water after exposure through the red and green positives. The blue picture can then be made on a separate plate, placing the positive film out so as to reverse it, and after exposure, washing the plate, and then superimposing and building up.

The apparatus for viewing these pictures is a lens cut square like a reading glass mounted on a light frame, provided with a black screen perforated with an eyehole.

WOOL, COTTON. (See "Cotton-wool.")

WOOLLINESS

A loss of correct texture, and a substitution of a vague irregularity of definition and tone suggestive of masses of wool. It may appear,

for example, in renderings of trees and water when the focusing has been faulty or there has been movement during exposure. It sometimes results from misguided efforts at control by working on the back of the negative.

WORKING UP NEGATIVES

Methods of treating the glass side of negatives with thin tracing paper or with matt varnish are described under the heading "Control in Printing." In addition, pencil work may be applied to the tracing paper to give increased emphasis to small portions or details. (See also "Retouching.")

WORKING UP PRINTS

A term usually applied to working up photographs by means of crayon or water colour. The air-brush may be employed effectively for soft, shaded or clouded backgrounds, or for any mass of shading that is required to be evenly or delicately graded or perfectly flat.

The prints most suited for treatment are those on matt-surfaced bromide or gaslight papers; the colour dries with a matt or smooth surface and becomes disagreeably evident on any paper with a semi-glossy surface, and still more prominent on a glossy print. The materials required are water colours and brushes of good quality, small saucers or china palettes for mixing the colours, and prepared ox-gall. A little of the last-named is mixed with the colour if the surface of the print is so repellent that the colour will not take readily. For black prints, the best pigments are lamp black, blue-black, ivory black, and zinc white or Chinese white. Ivory black is required only for warm black prints. For all excepting the deepest tones a little white should be mixed with the black to destroy its transparency and give body or solidity. All the pigments should be purchased in the moist form in tubes. For brown and purple-toned prints other pigments will be necessary, the most suitable being either Vandyke brown or burnt umber, which may be combined with ivory black for various shades of brown; and neutral tint and either scarlet madder or alizarin crimson for mixing different shades of purple. Crimson lake and carmine should be avoided, as they are very fugitive.

The aim should be to strengthen or modify in depth, and to follow the character of existing work as closely as possible. The added work should improve the photograph as a photograph. For this reason, the outlining of details should not be attempted.

In working up photographs for process reproduction, the colours employed must be such that their photographic value is the same as their visual effect. For working in black, process white, blanc d'argent, and process black should be employed. Blanc d'argent is not permanent, but it possesses great body and mixes with black for producing greys. Chinese white reproduces as a distinct grey.

WORTLEY'S PROCESS

A dry collodion process introduced by Col. Stuart Wortley, in which a solution containing salicin, tannin, gallic acid, alcohol, sugar, and water was used as a preservative.

Col. Wortley, in 1873, discovered that a strongly alkaline developer had a more powerful action than the weaker one previously employed. Much shorter exposures were thus rendered possible. In 1879, he found that a gelatine emulsion might be ripened—that is, increased in sensitiveness—equally well by keeping it for a few hours at a fairly high temperature as by maintaining it for days at a lower one.

WOTHLY'S PROCESS, OR WOTHLYTYPE

A process of printing-out, patented by Wothly in 1864, in which the sensitive salts were a mixture of the nitrates of uranium and silver dissolved in collodion. The prints were washed after insolation with acetic or hydrochloric acid, and then toned with gold chloride. This process

was practically the immediate predecessor of collodio-chloride printing-out papers.

WRINKLING OF FILM

When a film wrinkles at the edges it is known as frilling (*which see*). When the whole of the film is wrinkled in wavy lines the defect is known as reticulation (*which see*).

WRITING INK, PRINTS IN (See "Ink Process.")

WYNNE'S EXPOSURE METER (See "Exposure Meter.")

WYNNE'S PLATE SPEEDS (See "Sensitometry.")

X

XANTHO-COLLODION

An iodised collodion to which is added a tincture of powdered turmeric giving to it a rich yellow colour. Positives are made with it on black glass, giving an effect like a gilded daguerreotype.

X-RAYS (Fr., *Rayons X*; Ger., *X-Strahlen*, *Röntgen-Strahlen*)

Prof. Röntgen, in 1895, discovered certain rays, to which he gave the name of X-rays, and he investigated their action on the sensitive emulsion of the dry plate. X-rays are produced by the discharge of a high-potential current through a special form of vacuum tube, known as a Crookes' tube (*which see*). The positive terminal of an induction coil or Wimshurst machine is connected to the anode and the negative to the cathode of the tube. The anticathode is connected to the anode and is also positive. The vacuum of a tube is not perfect, and the current is conveyed through the tube by the infinitesimal quantity of air contained therein.

The "cathodal rays" which pass from the cathode to the anticathode consist of infinitesimal particles travelling at a high rate of speed; when the progress of these minute bodies is arrested, X-rays are produced. The green fluorescence on the sides of the tube opposite the anticathode, though not caused by the X-rays, demonstrate their presence. The X-rays are ethereal vibrations travelling with much the same velocity as light. They travel in a straight line in all directions from the point of origin, and are almost incapable of reflection or refraction.

X-rays are invisible to the eye, but have the property of rendering fluorescent certain substances—for example, calcium tungstate and barium platino-cyanide. When a screen coated with these substances is placed near the X-ray tube in a darkened room, the tungstate or barium surface emits a fairly bright fluorescence. If an object such as the hand or a lead pencil is placed between the screen and the tube,

the denser parts (the bones or the graphite) appear as black shadows in a grey background.

X-rays penetrate all substances to a greater or less degree, although heavy metals, such as lead and mercury, are, for photographic or visual purposes, practically opaque to the rays.

The greater part of X-ray examination is conducted by photographic methods, as the image given by the rays on a dry plate or film show far more detail than can be seen by visual examination with the fluorescent screen.

X-RAY DERMATITIS

A painful and incurable disease, of a cancerous nature, to which radiographers are liable, caused by frequent and prolonged exposure to X-rays. Many of the pioneers of radiography have fallen victims to this complaint, but greater precautions are now taken to protect the operators from the X-rays. There is little danger of contracting this disease in X-ray photography, as the exposures are short and the operator need not stand directly in front of the tube. The chief risk is entailed by visual examination with the fluorescent screen. The disease first makes its appearance in the hands and gradually spreads to the arms and body. The skin at first appears as if it had been burned, hence the term "X-ray burning."

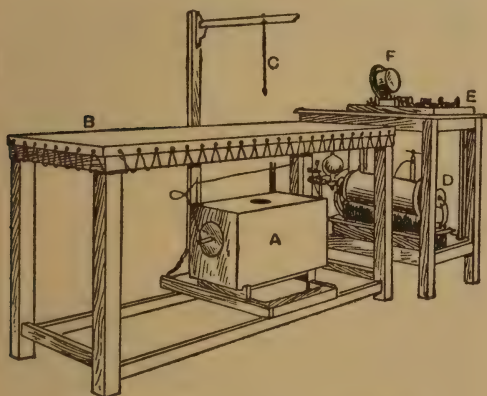
X-RAY PHOTOGRAPHY, OR RADIOGRAPHY (Fr., *Radiographie*; Ger., *Röntgenphotographie*)

There being no method of bringing X-rays to a focus, the images produced on the photographic emulsion are merely shadows of the objects. The illustration shows the outfit for radiography, A being a metal-lined box containing the X-ray tube; B, couch for patient; C, plumb for centring the tube; D, induction coil; E, switchboard; and F, ampere meter. X-ray photographs are produced by means of a high-voltage electrical apparatus and a Crookes' tube. The high pressure current necessary to produce fluorescence in the vacuum tube is obtained from a Wimshurst machine or

an induction coil. The Wimshurst machine is self-contained, the current being generated by revolving glass or vulcanite plates in opposite directions, but these machines have serious drawbacks, and the induction coil is now almost invariably used. The positive pole of the wires is connected to the anode, and the negative is connected to the cathode end of the tube. If the current flows in a reverse direction, the tube is quickly ruined. The half of the tube opposite the anticathode gives out a bright green fluorescence when the current is flowing from anode to cathode; but if the current is passing the reverse way, a flickering bluish-green fluorescence appears all over the tube.

A coil giving a 4-in. spark is sufficiently powerful for experimental radiography, but an 8-in. or 10-in. spark is the lowest that can be used for practical work.

The X-rays are not visible to the eye, and for the visual examination of objects a fluorescent screen of barium platino-cyanide must be used in a darkened room. Radiography, however, need not be conducted in a dark-room. The



Equipment for X-ray Photography

dry plates, packed in light-tight envelopes, are placed behind the object to be photographed, the film facing the tube. If only a 4-in. coil is used, the object must be as close as possible to the tube, but with a powerful coil the distance should be increased to about 30 in. to ensure a sharp image with but little distortion. In medical X-ray work, the patient is placed upon a couch consisting of a wooden frame covered with canvas. A box containing the tube moves on wheels and rails beneath the couch; it is lined with metal to shield the operator from the X-rays. The time of exposure depends upon the strength of current used, the power of the coil, and the condition of the tube. A "hard" tube—that is, a tube with an extremely high vacuum—requires less exposure than a "soft" or low-vacuum tube. The condition of the tube is ascertained by finding its "equivalent spark gap." While the coil and tube are working, the terminal points of the induction coil are slowly brought together. If a spark passes between the points while they are 6 in. or more apart, the vacuum is too high. If no sparking takes place between the terminals

till they are within 3 in. of each other, the tube is low. A good working spark gap distance is $4\frac{1}{2}$ in. A soft, or low-vacuum, tube gives better definition than a hard, or high-vacuum, tube, as the rays pass less easily through dense substances and show greater differentiation of tissue. A very high-vacuum tube may show but little difference between the bones and flesh, while a soft tube should give the minute structure of the bones. Tubes are now fitted with regulators for lowering the vacuum.

With a current of 5 amperes at 100 volts passing through the primary winding of a 10-in. coil, the exposure for a hand or foot would be from 3 to 15 seconds. The exposure for the thicker portions of the body would be from 20 seconds to 2 minutes. If an electrolytic break is used, about half the exposure would be required. Dry plates with extra thick sensitive films are specially prepared for radiography, the development and fixation being the same as in ordinary photography. The image is sometimes barely visible on the surface of the plate during development, but when fixed the negative may give good density and definition owing to the penetration into the film of the X-rays.

Several forms of "intensifying screens" have been introduced for the purpose of shortening exposure. The screens are coated with a substance giving a white or violet fluorescence. The coated side is placed in contact with the sensitive film of the dry plate which is exposed with the glass side facing the tube. Intensifying screens greatly reduce the exposure, but the quality of the negative is somewhat inferior owing to the grain of the screen being reproduced.

An energetic developer, such as metol-hydroquinone, is most suitable for radiography, and development should not be hurried.

The comparative resistance to X-rays of the following list of substances will give some idea of the penetrating power of the rays. The figures are only approximate, as the results vary with the hardness of the tube, etc. :—

The unit is a sheet of cardboard, and the other substances are supposed to be of equal thicknesses. Cardboard, 1; wood, $\frac{1}{2}$; linen, 2; rubber, $\frac{3}{4}$; iron, 1,000; glass, 40; lead, 3,000.

Dry plates must not be stored in an X-ray room except in metal chests, as the paper boxes and envelopes give no protection to the sensitive film.

In X-ray work the operator often has to find the position and depth of some foreign object, such as a needle in the human body. This can be ascertained by visual examination with the fluorescent screen from both vertical and lateral points of view. The best method for finding the depth of a foreign body is to take two radiographs on the same plate, moving the tube to one side before the second exposure is given. Two images will appear on the plate, and the position of the foreign body is calculated from the separation of the two images and the distance of the tube from the plate.

J. I. P.

XYLO-AUTOGRAPHY

A half-tone block worked on by a wood-engraver to imitate the effects of wood engraving.

XYLOGRAPHS

Positive pictures by the wet collodion process, toned and transferred to a paper support, and thence to a wood block as a guide for the wood engraver.

XYLOGRAPHY, PHOTO (See "Wood, Photographs on.")

XYLOIDIN

A substance analogous to pyroxyline and pro-

duced by acting on starch with a mixture of pyroxyline and acids. It dries from its solutions as a matt opaque film, which is very inflammable and explosive.

XYLONITE

A synonym for celluloid.

XYLO-PHOTOGRAPHS

Photographs made upon wood for engraving purposes.

Y**YELLOW GLASS**

This is used in the production of the yellow light referred to in the next article.

YELLOW LIGHT

Used for dark-room illumination in the early days of photography, and before the introduction of fast dry plates. It may be used at the present time for bromide paper, lantern plates, and very slow dry plates, but not for dry plates of even the "ordinary" speed. Although a patent was taken out for a ruby light in 1844, yellow light was more widely used during the collodion period, say 1851 to 1880, as it was quite safe for the plates then in use.

YELLOW NEGATIVES

Yellowness in a negative must be regarded as a defect. The time required for printing is very long, and the result of intensifying or reducing must always be uncertain. The usual causes of yellowness are absence or insufficiency of sulphite in the developer, prolonged development with excess of alkali, and fixing in a stale or discoloured "hypo" solution. A good acid fixing bath, if not overworked, will largely correct the tendency to staining from the first two causes. Thiocarbamide is the most satisfactory reagent for removing the yellow stain.

When negatives gradually become yellow after finishing, or when they develop a yellow staining during the process of mercurial intensification, the cause is, almost invariably, imperfect fixing, that is, either too short an immersion in the

fixing bath or the use of an exhausted fixing solution; there is no remedy for such stains.

YELLOW PRINTS

Bromide prints may show a yellow discoloration from the same causes as those given for yellow negatives. If a print is allowed to float on the top of the fixing solution, face upwards, it is almost certain to become yellow stained. Prints should be fixed face downwards. A weak bath of thiocarbamide is the most effective method of removing yellow staining.

YELLOW PRUSSATE OF POTASH (See "Potassium Ferrocyanide.")

YELLOW SCREENS (See "Isochromatic Screens.")

YELLOW STAINS

Yellow stains, in isolated patches, on negatives may arise from several causes. If too small a quantity of fixing solution is used, and parts of the negative become uncovered and exposed to the air during fixing, those parts will show a yellow discoloration. This cause can easily be identified, as the yellow stains are visible as soon as the plate is taken from the fixing bath. They are very difficult to remove, thiocarbamide being the most successful reagent.

Yellow stains that develop gradually after the plate is fixed, or those that arise in mercurial intensification, are due entirely to imperfect fixing. There is no method of removing them. (See also "Yellow Negatives" and "Yellow Prints.")

Z**ZANDER'S COMPLEMENTARY COLOUR PROCESS**

A colour reproduction process invented and patented in 1905 by C. G. Zander, who called it the "Complementary Colour Process." The inventor assumed that it was necessary to use not three, but four, fundamental colours, namely, red, yellow, green and blue, by mixture of which,

in suitable proportions, any colours in Nature could be matched. The hues of these four fundamental (or monochromatic) colours may, in popular terms, be described as magenta red, lemon yellow, emerald green, and ultramarine blue. The four colours were grouped into two pairs of complementary colours, namely, red and green and yellow and blue, so that when

the elements of either pair were mechanically mixed as pigments, by printing or staining, they produced black. The inventor claimed that practically the whole range of the spectrum colours could be produced by this process, besides extra spectral purples, dense pure black and homogeneous greys. Zander asserted that no pure black can be reproduced at all in three-colour printing, whilst by his process either of the two pairs would produce black or grey.

ZAPON VARNISH, OR ZAPONLAC

A varnish consisting of celluloid dissolved in amyl acetate. It gives a brilliant surface, impervious to heat or moisture, and may be used for negatives and positives, or as a lacquer for trays. "Zapon" is a proprietary and registered name.

ZENKER, DR. WILHELM

Born 1829; died 1899. A distinguished astronomer and physicist, of Berlin. He published, in 1868, *Lehrbuch der Photochromie*, treating of all the then known methods of colour photography, or approximations thereto. In it he suggested the theory of standing or stationary waves, on which Lippmann's process of interference heliochromy essentially depends.

ZENOTYPE

A process of toning introduced by E. J. Browne in 1894. A powder was supplied commercially which, when dissolved in water, was used as a developer to produce coloured prints.

ZINC, BLACKENING (See "Blackening Apparatus.")

ZINC BROMIDE (Fr., *Bromure de zinc*; Ger., *Zinkbromid*)

ZnBr_2 . Molecular weight, 225. Solubilities, 1 in .3 water; very soluble in alcohol and ether. It is a white hygroscopic crystalline powder, obtained by dissolving zinc carbonate in hydrobromic acid. It is occasionally used in collodion emulsion making.

ZINC CHLORIDE (Fr., *Chlorure de zinc*; Ger., *Zinkchlorid*)

ZnCl_2 . Molecular weight, 136. Solubilities, 1 in .3 water; soluble in alcohol and ether. It is poisonous, the antidotes being alkaline carbonates preceding water or milk, albumen, etc. It is a white powder which is very deliquescent, and is obtained by dissolving zinc or zinc carbonate in hydrochloric acid. It is used in collodion emulsion making.

ZINC ETCHING (Fr., *Zincographie*; Ger., *Zinkhochätzung*)

The process of reproducing line originals by transferring the image to zinc and etching into relief. Strictly speaking, the term applies to Gillot's original process, in which the image was put down on zinc by means of a lithographic transfer or by drawing on the zinc with lithographic ink or crayon as a preliminary to etching into relief with acid, but the term is also now applied to the "photo-zinc process." Zinc etchings are all kinds of etched zinc plates from line originals, or the equivalent of line

originals, such as coarse crayon grain, stipple, transfers from type or engraved copper and steel plates and woodcuts—anything, in fact, which has not to be reproduced by the half-tone screen.

ZINC HYPOCHLORITE (Fr., *Hypochlorite de zinc*; Ger., *Zinkhypochlorit*)

ZnOCl_2 . Molecular weight, 152. It is a somewhat indefinite compound, obtained by mixing solutions of zinc sulphate and bleaching powder and filtering out the calcium sulphate. Formerly it was used to eliminate the last traces of "hypo," but it has now scarcely any practical application.

ZINC IODIDE (Fr., *Iodure de zinc*; Ger., *Zinkiodid*)

ZnI_2 . Molecular weight, 319. Solubilities, 1 in .3 water, soluble in alcohol and ether. It is a white deliquescent powder, obtained by dissolving zinc oxide in iodic acid or direct union of zinc and bromine, and it is used for making collodion emulsion.

ZINC OXIDE (See "Zinc White.")

ZINC PLATES

The zinc plates used in process work are of two kinds—thin, with grained surface for photo-lithography, and thick with polished surface for etching. A very pure zinc is requisite for process work, and the plates must be perfectly rolled, and free from surface blemishes. The thin zinc for lithography is chemically treated to free it from grease, and then grained in a trough filled with marbles and sand, which is then given a jogging motion. A fine matt is given to the surface. The thicker zinc, usually 16 B.W.G., or .065 in. thick, is scraped and polished by buffing with abrading and polishing powders mixed with oil, until a high finish is obtained. Before use, the greasiness is removed by rubbing with pumice powder and water, and by passing through a bath of weak acid and alum.

ZINC SULPHATE (Fr., *Sulfate de zinc*; Ger., *Zinksulfat*)

Synonyms, white vitriol, zinc vitriol. $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$. Molecular weight, 287. Solubilities, 1 in .62 water, insoluble in alcohol. It is in the form of colourless acicular crystals that effloresce in dry air. It is obtained by the direct action of sulphuric acid on zinc, and is used to form zinc hypochlorite.

ZINC, TRANSFERRING TO

Transfers may be put down on zinc in the same way as upon lithographic stones. The transfer, in lithographic ink on suitable transfer paper, is damped from the back, and laid down on a perfectly clean matted zinc plate; then the plate bearing the transfer is run through a lithographic press several times with increasing pressure. The back of the transfer paper is then damped and peeled off, leaving the ink image on the zinc. This is then treated with a solution of gum and nutgalls and rolled up with ink. The plate may then be printed from lithographically or etched into relief.

ZINC WHITE

Zinc oxide, ZnO . It enters into the composition of some of the white pigments used for retouching photographs for reproduction, and it has the advantage that it does not discolour so readily as the whites formed from lead pigments. It photographs darker than paper. (See also "Chinese White.")

ZINCOGRAPHY (Fr., *Zincographie*; Ger., *Zinkographie*)

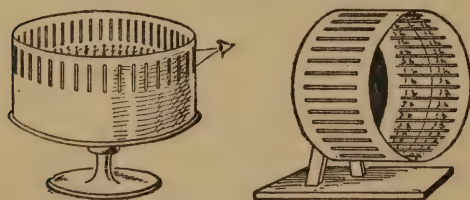
The process of lithography from zinc plates, first brought into regular use by Col. Sir Henry James, in 1859, at the Ordnance Survey Office, Southampton, for map printing. Originally the image was put down on the zinc by lithographic transfer, but this has been superseded by photo-zincography, which at first involved the making of a print on photo-lithographic transfer paper. This, in turn, has given way to methods of printing direct from the negative, or through the drawing, as in the Vandyke process.

ZIRCONIUM (Fr., *Zirconium*; Ger., *Zirkon*)

One of the rarer metals from which is obtained zirconium oxide, which has been suggested as a substitute for the lime in the oxyhydrogen light, and is also used in making incandescent gas mantles.

ZOËTROPE, OR "WHEEL OF LIFE"

An open cylinder with vertical slits round its sides, and below them a series of motion pictures which were viewed through the slits as the cylinder revolved on its stand, the result being a kinematograph effect. It embodies in cylindrical form the principle of an earlier disc device—the phenakistoscope (*which see*), and was invented by Desvignes in 1860. In 1867, a patent for the same device was granted in the United States of America to William E. Lincoln, of Providence, who was the first to call it the



A. Zoëtrope

B. Stereoscopic Zoëtrope

zoëtrope. But this type of slotted machine had its origin at a date far anterior to those quoted above; in fact, only a little more than a twelve-month elapsed between the invention of the phenakistoscope (1833) and the publication by W. G. Horner in *The Philosophical Magazine* of a description of a device strongly resembling the zoëtrope. The apparatus in its modern form is shown at A. A band of pictures having been placed inside the cylinder, the whole is rotated, when the figures are seen in motion.

A great variety of zoëtropic instruments have been devised, one of the most interesting being the stereoscopic zoëtrope shown at B. Anschütz used this form to produce the appearance of motion from a series of animal movements photographically recorded. The series of phases was taken in stereoscopic sets, and, as is shown, the cylinder was turned on its side, and the slits were long enough to permit of both eyes gaining a view of their respective series; the blending of the two series was brought about by suitable prisms or other optical device.

ZÖLLNER'S PROCESS

An iodide of starch printing process, invented in 1863 by Dr. F. Zöllner, of Berlin, and used for reproducing plans, drawings, etc. Thin, smooth paper is sized with starch, and sensitised by floating for from thirty to sixty seconds on a solution of ferric chloride and ferric oxalate. The exposure varies from two or three minutes in the sun to fifteen or thirty minutes in diffused light, the image being at first invisible. The exposed prints should not be left longer than twelve hours before developing. The image appears of an intense blue colour on brushing on a solution of potassium iodide in dilute albumen. The developer should be washed off the print before it has time to dry, and the washed prints dried in the open air. To prepare the developing solution, the whites of two eggs of average size are well beaten and left for several hours, after which the liquid albumen is decanted from the bottom of the vessel and diluted with one-third its quantity of distilled water, 78 grs. of potassium iodide being then added and dissolved.

ZOOLOGICAL PHOTOGRAPHY

This includes not only the photography of animals and birds, but also of nests and eggs, insects, and their larvæ and pupæ, reptiles, fish, etc. Under separate headings will be found much information on these subjects, and in this place only general remarks will be given. The chief aim of all naturalistic photography is realism. Texture of all kinds should therefore be most truthfully indicated, and no pains be spared to secure the highest technical excellence; not only should knowledge of the particular branch of natural history dealt with be acquired, but careful consideration should be devoted to accurate colour rendering, exposure, development, and printing methods. Within limits, some form of colour plate is of great value to the natural history photographer, especially for use as lantern slides; and this value will increase with the inevitable advance in the speed and quality of the plates available. (See also "Animals, Photography of," "Birds, Photography of," "Fish, Photographing," "Insects, Photographing," "Reptiles, Photography of.")

ZOÖPRAXISCOPE

An instrument used to exhibit studies of animals in motion; a forerunner of the kinematograph.

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